See the possibilities

Spark Series

User Manual

SP-5000M-GE2
SP-5000C-GE2

5M Digital Progressive Scan
Monochrome and Color Camera

Document Version: Ver.1.3
SP-5000-GE2_Ver.1.3_Oct2014

1050E-1404

Notice

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Warranty

For information about the warranty, please contact your factory representative.

Certifications

CE compliance

As defined by the Directive 2004/108/EC of the European Parliament and of the Council, EMC (Electromagnetic compatibility), JAI Ltd., Japan declares that SP-5000M-GE2 and SP-5000C-GE2 comply with the following provisions applying to its standards.
EN 61000-6-3 (Generic emission standard part 1)
EN 61000-6-2 (Generic immunity standard part 1)

FCC

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Warning

Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

Supplement

The following statement is related to the regulation on " Measures for the Administration of the control of Pollution by Electronic Information Products " , known as " China RoHS ". The table shows contained Hazardous Substances in this camera.

mark shows that the environment-friendly use period of contained Hazardous Substances is 15 years.

重要注意事项

有毒，有害物质或元素名称及含量表

根据中华人民共和国信息产业部『电子信息产品污染控制管理办法』，本产品《 有毒，有害物质或元素名称及含量表 》如下.

部件名称	有毒有害物质或元素					
	铅（Pb）	汞（Hg）	镉（Cd）	六价铬（Cr(VI)）	多溴联苯（PPB）	多溴二苯醚（PBDE）
螺丝固定座	×	○	○	○	○	○
连接插头	×	○	○	○	○	○
电路板	×	○	○	○	○	○
.....	.....	.....	.....	.....	.....	.....

○：表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006规定的限量要求以下。
×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006规定的限量要求。
（企业可在此处、根据实际情况对上表中打 " × " 的技术原因进行进一步说明。）

环保使用期限

电子信息产品中含有的有毒有害物质或元素在正常使用的条件下不会发生外泄或突变、电子信息产品用户使用该电子信息产品不会对环境造成严重污染或对基人身、财产造成严重损害的期限。

数字「15」为期限15年。

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	铅（Pb）	汞（Hg）	镉（Cd）	六价铬（Cr(VI)）	多溴联苯（PPB）	多溴二苯醚（PBDE）
螺丝固定座	×	○	○	○	○	○
光学滤色镜	×	○	×	○	○	○
连接插头	×	○	○	○	○	○
电路板	×	○	○	○	○	○
…….	…….	…….	…….	…….	…….	…….

○：表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006规定的限量要求以下。
×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006规定的限量要求。
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数字「15」为期限15年。

- Contents -

Introduction

Before using GigE Vision® camera

All software products described in this manual pertain to the proper use of JAI GigE Vision® cameras. Product names mentioned in this manual are used only for the explanation of operation. Registered trademarks or trademarks belong to their manufacturers.
To use the JAI SDK, it is necessary to accept the "Software license agreement" first.

This manual describes necessary equipment and the details of camera functions.

1 JAI GigE Vision® camera operation manuals

To understand and operate this JAI GigE Vision camera properly, JAI provides the following manuals.

User's manual (this booklet)	Describes functions and operation of the hardware
JAI SDK & Control Tool User Guide	Describes functions and operation of the Control Tool
JAI SDK Getting Started Guide	Describes the network interface

User's manual is available at **www.jai.com**

2 Software installation

The JAI GigE Vision SDK & Control Tool can be downloaded from the JAI web site at www.jai.com.
The JAI SDK is available for Windows XP, Vista, and Windows 7, 32-bit and 64-bit.
For the details of software installation, please refer to the "Getting Started Guide" supplied on the JAI SDK download page.

Important: Please note that if you use LAG function, refer to the chapter 5.1.1.5 first. It explains the order to install NIC driver and SDK.

3 About GigE Vision Ver2.0

SP-5000-GE2 complies with the latest GigE Vision version 2.0. GigE Vision is the new standard interface using Gigabit Ethernet for machine vision applications and it was mainly set up by AIA (Automated Imaging Association) members. GigE Vision is capable of transmitting large amounts of uncompressed image data through an inexpensive general purpose LAN cable for a long distance.

GigE Vision also supports the GenICam™ standard which is mainly set up by the EMVA (European Machine Vision Association). The purpose of the GenICam standard is to provide a common program interface for various machine vision cameras. By using GenICam, cameras from different manufactures can seamlessly connect in one platform.

As a new extension of standards, GigE Vision Ver.2.0 employs Link Aggregation which combines two independent ports and identifies these as one port, making much higher transfer rates possible; PTP (IEEE 1588) which provides more precise time management; and Manifest which enables either GigE Vision Ver.1.X or Ver.2.0 on demand. SP-5000-GE2 complies with those extensions. For the details, please refer to Chapter 5.1.

For details about the GigE Vision standard, please visit the AIA web site, www.machinevisiononline.org and for GenICam, the EMVA web site, www.genicam.org.

4 Recommended PC to be used

The PC used should have the following performance or better

1) Recommended CPU : Core i3 or better,
2) Recommended memory: DDR3, 4GB fully equipped (Windows 7 32-bit)
   DDR3, 8GB fully equipped (Windows 7 64-bit)
3) Graphics card : Should apply with PCI Express Generation 3.0 or better
4) NIC : Use Intel NIC
   PCI-Express Bus to install Intel NIC should be better than Generation 2.0. Generation 1.0 cannot be used.
5) Other: If the picture is always displayed on the monitor, it is not recommended to use the CPU in the PC.

5 About the network card to be used

SP-5000-GE2 complies with Link Aggregation which handles two ports as one port. To make the best use of this function, the network card used should comply with 1000BASE-T as well as Link Aggregation. It also complies with Jumbo Frame. If Jumbo Frame is set to a large value, the PC processing load can be reduced. The packet overhead is also reduced and as the result, the bandwidth of the communication line has more room.

Table1. NIC

NIC manufacturer	Model	PCI-Express Bus	Data
Intel	PRO/1000PT, dual port Server Adapter	√ (x4)	
Intel	Gigabit ET2, Quad port Server Adapter	√ (x4)	10 Gbps uni-directional 20 Gbps bi-directional
Intel	i340-T4, Quad port Server Adapter	√ (x4)	

Note: Intel Pro/1000PT Quad does not comply with Link Aggregation.

6 Cables to be used

GigEVision configures the system by using 1000BASE-T.
In the market, CAT5e (125MHz), CAT6 (250MHz) and CAT7 (600MHz) cables are available for 1000BASE-T. There are crossover cables and straight through cables available. Currently, as most equipment complies with Auto MDI/MDI-X, please use straight through cables. (Among crossover cables, a half crossover type exists, which the Ethernet will recognize as 100BASE-T).

7 EMVA 1288

With regard to signal to noise ratio in this manual, specifications measured by EMVA 1288 are used together with specifications by a traditional measurement method.
EMVA 1288 is a more complete measurement that considers multiple noise sources, including random noise, pattern noise, and shading. Additionally, EMVA 1288 incorporates temporal variances in pixel output by capturing 100 frames of data and computing the RMS variations over the captured frames. Because of the comprehensive nature of the noise analysis and the additional consideration for RMS variances over time, EMVA 1288 SNR measurements are inherently lower than the traditional SNR measurements given by manufacturers. However, the comprehensive nature combined with rigid test parameters, means that all manufacturers are measuring their products equally and EMVA 1288 tested parameters can be compared among different manufacturers' products.
In order to learn more about EMVA 1288, please visit http://www.emva.org

Camera Operation Manual

1. General

The SP-5000M-GE2 and SP-5000C-GE2 are among the first new Spark Series cameras to be introduced. They are high performance cameras with high resolution and a fast frame rate suitable for high speed machine vision applications. The SP-5000M-GE2 is a monochrome progressive scan CMOS camera and the SP-5000C-GE2 is the equivalent Bayer mosaic progressive scan CMOS camera. Both are equipped with a CMOS sensor offering a 1-inch optical format, a resolution of 5.24 million pixels, and a 5:4 aspect ratio. They provide up to 44 frames per second for continuous scanning with 2560 x 2048 full pixel resolution for both monochrome and raw Bayer output.

8-bit or 10-bit output can be selected for both monochrome and raw Bayer formats. The SP-5000C-GE2 is also capable of performing in-camera color interpolation at reduced frame rates. The new cameras feature a GigE Vision Ver. 2.0 interface which has a new Link Aggregation (LAG) extension. LAG handles two ports as one port and this function enables higher data transfer rates in an Ethernet environment.

The SP-5000M-GE2 and SP-5000C-GE2 have various comprehensive functions needed for automated optical inspection applications, such as solid state device inspection or material surface inspection. They incorporate video processing functions such as a look-up table, shading compensation and blemish compensation in addition to fundamental functions such as trigger, exposure setting and video level control.

As a common Spark Series feature, a new connector for lens control is employed. SP-5000M-GE2 and SP-5000C-GE2 support P-iris and motor-driven lenses as standard lens control capabilities. Factory options are available to configure this connector to support DC iris systems, as well as provide a video iris output signal, or to provide additional TTL IN and OUT lines.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of the Camera Control Tool for the SP-5000M-GE2 and SP-5000C-GE2 can be downloaded from: www.jai.com
For camera revision history, please contact your local JAI distributor.

2. Camera composition

The standard camera composition is as follows.

Camera body	1
Sensor protection cap	1
Dear Customer (sheet)	1

The following optional accessories are available.

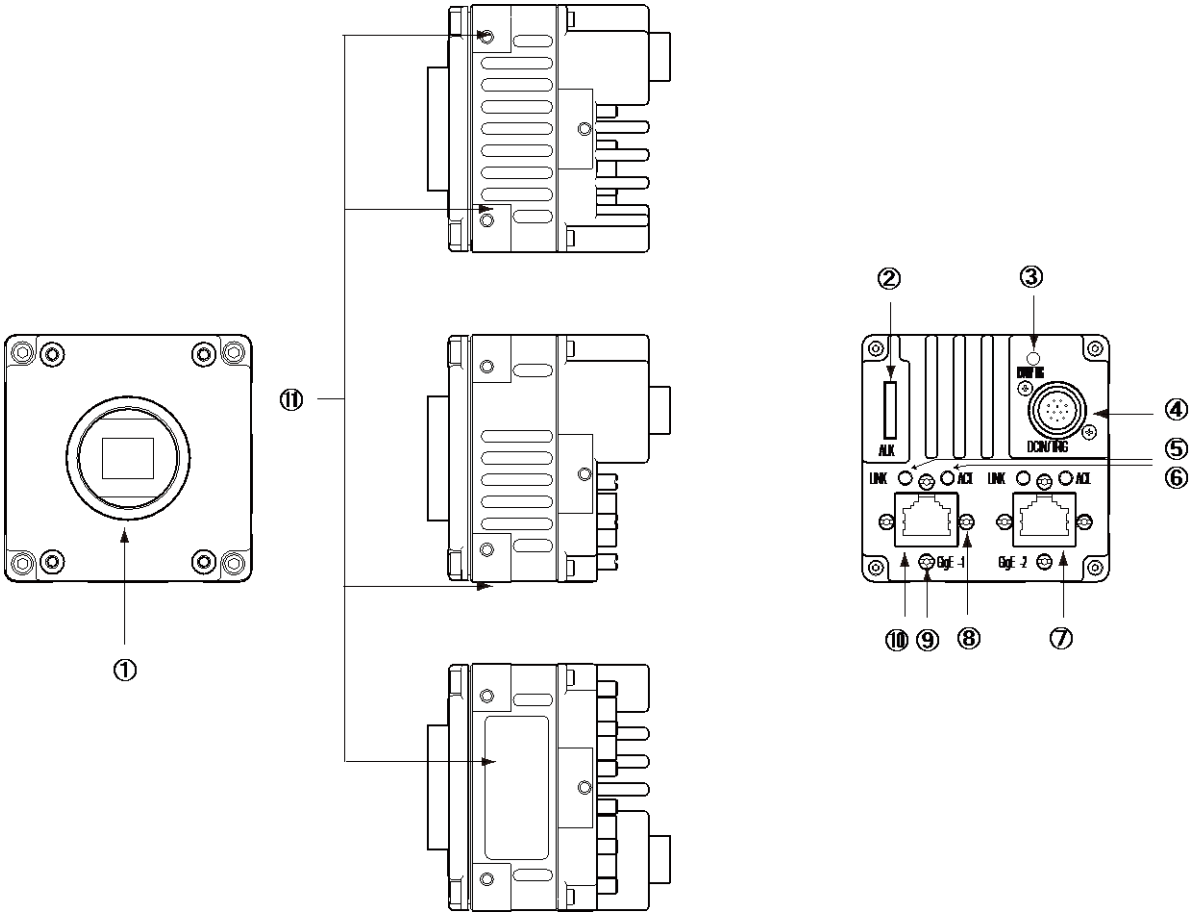
Tripod base	MP-42
Power supply unit	PD-12 series

3. Main features

- New Spark Series, 1” progressive scan camera
- Intelligent body design for easy and flexible installation
- Utilizes new GigE Vision ver.2.0
- Aspect ratio 5:4, 2560(H) x 2048(V) - 5.2 million effective pixels
- 5 µm square pixels
- S/N 55 dB for monochrome and 53 dB for color
- 8-bit or 10-bit output for monochrome and Bayer
- In-camera color interpolation choices include 3 x 8-bit RGB, YUV411, YUV422, or YUV444
- 44 frames/second with full resolution in continuous operation (2 ports, 8-bit)
- Various readout modes, including horizontal and vertical binning (SP-5000M-GE2 only) and ROI (Region Of Interest) for faster frame rates
- 0 dB to +24 dB gain control for both SP-5000M-GE2 and SP-5000C-GE2
- 10 µs (1/100,000) to 8 seconds exposure control in 1 µs step
- Auto exposure control
- Timed and trigger width exposure control
- RCT and PIV trigger modes for specific applications
- ALC control with combined function of AGC, auto exposure and auto iris
- HDR (High Dynamic Range) function is available (SP-5000M-GE2 only)
- Various pre-processing circuits are provided
  Programmable LUT
  Gamma correction from 0.45 to 1.0
  Shading correction
  Bayer white balance with manual or one-push auto (SP-5000C-GE2 only)
  Blemish compensation
- New Hirose 10P connector for lens interface including P-Iris lens control
- C-mount for lens mount
- Setup by Windows XP/Vista/7/8 via serial communication

4. Locations and functions

4.1 Locations and functions



①	Lens mount	C-mount (Note *1)
②	10-pin connector	AUX Connector for lens control (Standard)
③	LED	Indicator for power and trigger input
④	12-pin connector	DC and trigger input
⑤	LED (LINK)	GigE network indication (LINK for GigE 1)
⑥	LED (ACT)	GigE network indication (ACT for GigE 1)
⑦	RJ45 connector	GigE connector 2 (With lock mechanism)
⑧	Hole for RJ-45 fixing screw	Hole for RJ-45 fixing screw (Horizontally) (Note*2)
⑨	Hole for RJ-45 fixing screw	Hole for RJ-45 fixing screw (Vertically) (Note*2)
⑩	RJ45 connector	GigE connector 1 (With lock mechanism)
⑪	Mounting holes	Holes for mounting tripod base or direct installation. Depth 5 mm (Note*3)

Note1: Rear protrusion on C-mount lens must be less than 10.0 mm.
Note2: When an RJ-45 cable with thumbscrews is connected to the camera, please do not Excessively tighten screws by using a screw driver. The RJ-45 receptacle on the camera might be damaged. For security, the strength to tighten screws is less than 0.147 Newton meter (Nm). Tightening by hand is sufficient in order to achieve this.
Note3: The part number for the tripod adapter plate (with 1/4"-20 thread) is MP-42 (option).

Fig. 1 Locations

4.2 Rear panel

The rear panel mounted LEDs provide the following information:

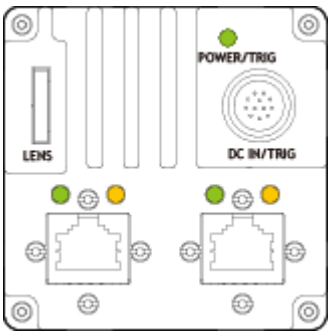


Fig. 2 Rear panel

POWER/TRIG
- Amber: Power connected – initiating
  This light goes OFF after initiating.
- Steady green: Camera is operating in Continuous mode
- Flashing green: The camera is receiving external triggering

Note: The interval of flashing does not correspond with external trigger duration.

GigE 1
LINK
- Steady green: Connecting in 1000BASE-T
- Flashing green: Connecting in 100BASE-T

ACT
- Flashing amber: GigE Network indication

LINK2
LINK
- Steady green: Connecting in 1000BASE-T
- Flashing green: Connecting in 100BASE-T

ACT
- Flashing amber: GigE Network indication

5. Input and output

5.1 GigE interface

5.1.1 GigEVision 2.0 interface extension

SP-5000-GE2 complies with GigE Vision 2.0. Its extension functions are described below.

5.1.1.1 Link Aggregation

By handling two ports as one port, the maximum transfer rate can be achieved at 2Gbps.
This function is based on IEEE 802.3ad, IEEE 802.1AX Link Aggregation and GigE Vision 2.0.

Table 2. Link Aggregation Specifications

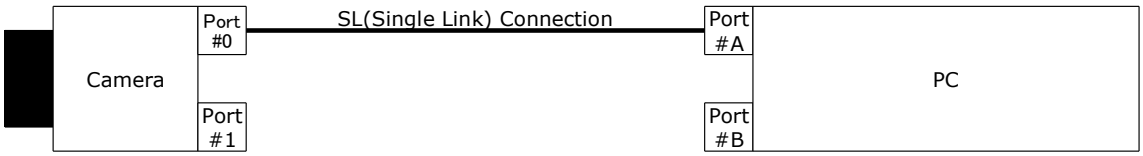
Link Aggregation system	sLAG(Static Link Aggregation Group) and dLAG(Dynamic Link Aggregation Group)	When dLAG is selected, LACP selects automatically. When sLAG is selected, if HW conditions are not satisfied, SL(Single Link) is activated.
Load distribution system	Round-robin processing	GVSP Ether Frame is output from Port 1 or Port 2 alternatively.
		When the first packet (Leader packet : Leader frame) of the video frame is output, the output port is reset to 1.
Physical Network Number	2 Ports	Port 1 and Port 2 are enabled.
		Multi Link (ML) is not supported.
MAC Address Number	1	As only SL, sLAG and dLAG are supported, MAC Address is one. Port 1 and Port 2 use the same MAC Address.（Note 1）
IP Address Number	1	As only SL, sLAG and dLAG are supported, IP Address is one. Port 1 and Port 2 use the same IP Address.（Note 1）
		IP Address is set up at the port which is linked up initially.
GVCP Port	Automatic selecting	The transmission is executed through the port which receives GVCP command.
Stream Channel Number	1 Channel	When SL is used, one stream is output from either Port1 or Port2 which is linked up. When sLAG or dLAG is used, one stream is output in load-balanced from Port 1 and Port2.
SL/sLAG Selecting Method	Selected by the status of Port Link UP	If only 1 port is linked up, it is SL.
		If sLAG is enabled, and if Port 1 and Port 2 are linked up, the status is changed to sLAG.
		If dLAG is enabled, and if Port 1 and Port 2 are linked up, the status is set to dLAG by LACP. If only one port is linked up, the status is reverted to SL.
		On sLAG or dLAG status, if one port is linked down, the status is reverted to SL.
Event Message	GEV_EVENT_LINK_SPEED_CHANGE	If a change of SL to or from LAG occurs, GEV_EVENT_SPEED_CHANGE Event Message can be issued.

Note 1: In Link Aggregation operation, two ports use the same MAC Address and IP Address. Accordingly, if these two ports are connected to only one non-compliant IEEE 802.3ad or IEEE 802.1AX switch, the function is not properly executed. If non-compliant IEEE 802.3 and/or IEEE 802.1AX switch is used, 2 sets should be used and connected to each port.

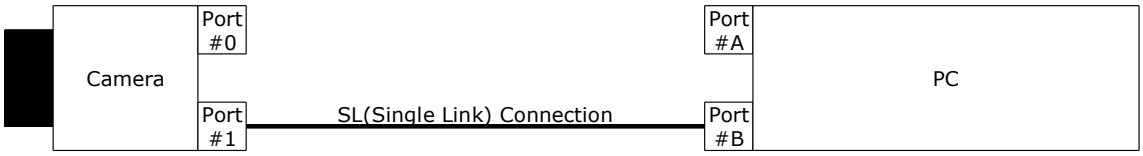
Connecting configuration

1. If only 1 port is linked up, the connecting configuration is SL (Single Link).
2. If Port 1 and Port 2 are linked up, and if dLAG is enabled, the operation is determined by LACP or if sLAG is enabled, the operation is sLAG connecting configuration.
3. If the connecting status is changed, the operation is automatically changed to appropriate connecting configuration.

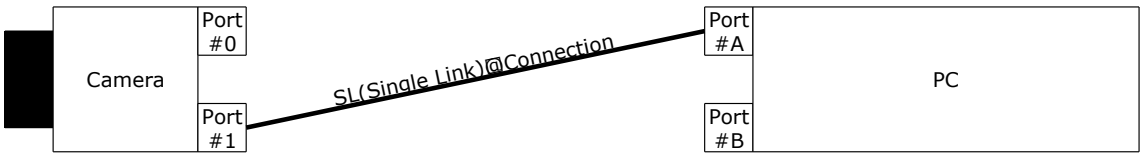
(1) 1Gbps (1000Mbps)



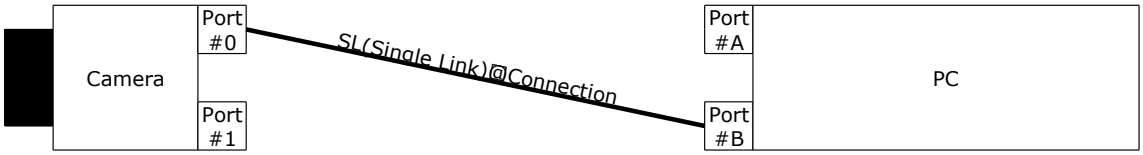
(2) 1Gbps (1000Mbps)



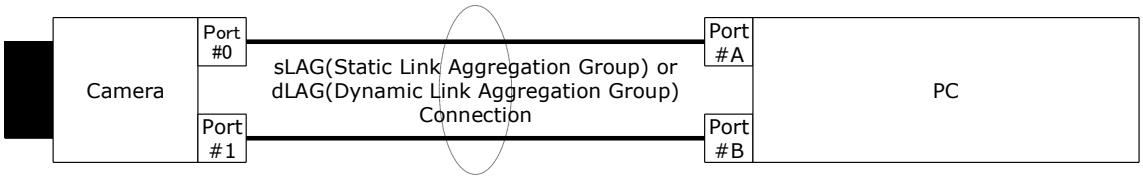
(3) 1Gbps (1000Mbps)



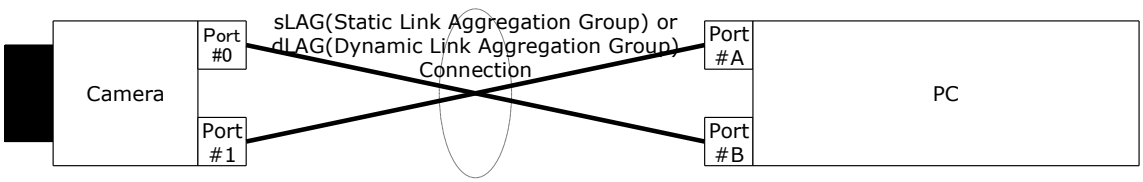
(4) 1Gbps (1000Mbps)



(5) 2Gbps (2000Mbps)



(6) 2Gbps (2000Mbps)



5.1.1.2 PTP (IEEE 1588-2008: Precision Time Protocol)

Table 3. Specifications

Equipped functions	Only slave		Master function is not equipped
Used Transport	Multicast UDP datagram But, Delay_Req and Delay_Resp are Unicast UDP datagram		In IEEE 1588, various transports including Ether Frame are defined. In GigE Vision 2.0, it is defined to use UDP datagram.
Destination Port number	Event message: 319		Sync, Delay_Req, Pdelay_Req, Pdelay_Resp
	General mesage: 320		Announce, Follow_Up, Delay_Resp, Pdelay_Resp, Management, Signaling
Multicast address	224.0.1.129		
Synchronized item	Time only		Frequency synchronization is not equipped
PTP Time Data (Comply with IEEE 1588)	bit length	80 bit	Time with 1 ns unit increment starting at 00:00:00 on 1/1/1970
Camera Time Stamp	bit length	64 bit (Note2)	At PTP synchronization, LSB 64 bit of PTP time data At PTP non-synchronization, 1 ns unit increment at starting on any time (Note 1)
Applicable PTP Message	Announce message		Receiving only
	Sync message		Receiving only
	Follow_Up message		Receiving only (used if the master is 2 step clock)
	Delay_Req message		Sending only
	Delay_Resp message		Receiving only
GigE Vision proper regulation	Timestamp Tick Frequency register value is fixed at 1,000,000,000 (1 GHz). (Note 3)		
	While PTP synchronizing operation, Timestamp Reset function is disabled and if the reset is required, GEV_STATUS_WRITE_PROTECT status code is returned.		

Note1: If there is IEEE 1588 master clock in the network, the camera time stamp is synchronized at the master clock.
If there is no IEEE 1588 master clock in the network, the camera time stamp operates by the free running of the internal clock at starting on the power being ON.

Note2: In GenICam standard, 64-bit integer is handled as signed value, thus only 63 bits are available through GenICam interface.

Note3: As 1 GHz clock is not actually operated, the time stamp is incremented by 8 (1 GHz/125 MHz) on every 1 clock of actual frequency.

5.1.1.3 Manifest

SP-5000-GE2 is equipped with Manifest. Both GenICam Version 1.x and Version 2.0 are applied by selecting the entry.

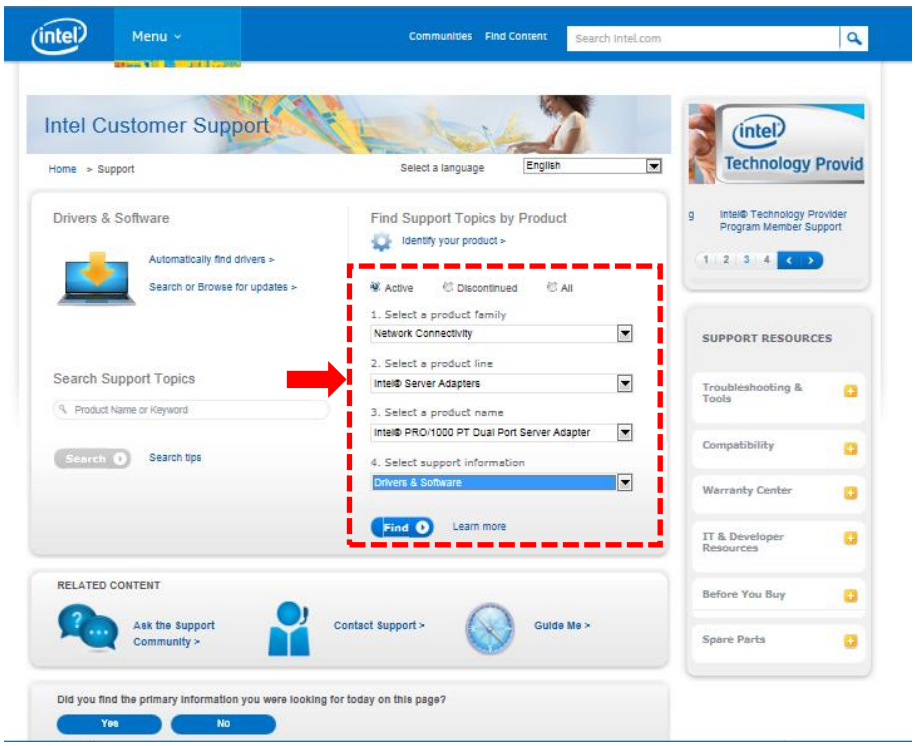
5.1.1.4 Notes for connecting 100BASE-TX

- In order to use 100 Mbps network, 100BASE-TX and Full Duplex are available. Half Duplex cannot be used.
- In the case of connecting on 100BASE-TX, the maximum packet size should be 1500 bytes.
- In the case of connecting on 100BASE-TX, the specifications such as frame rate, trigger interval and so on described in this manual cannot be satisfied.

5.1.1.5 Example of setting method of Link Aggregation

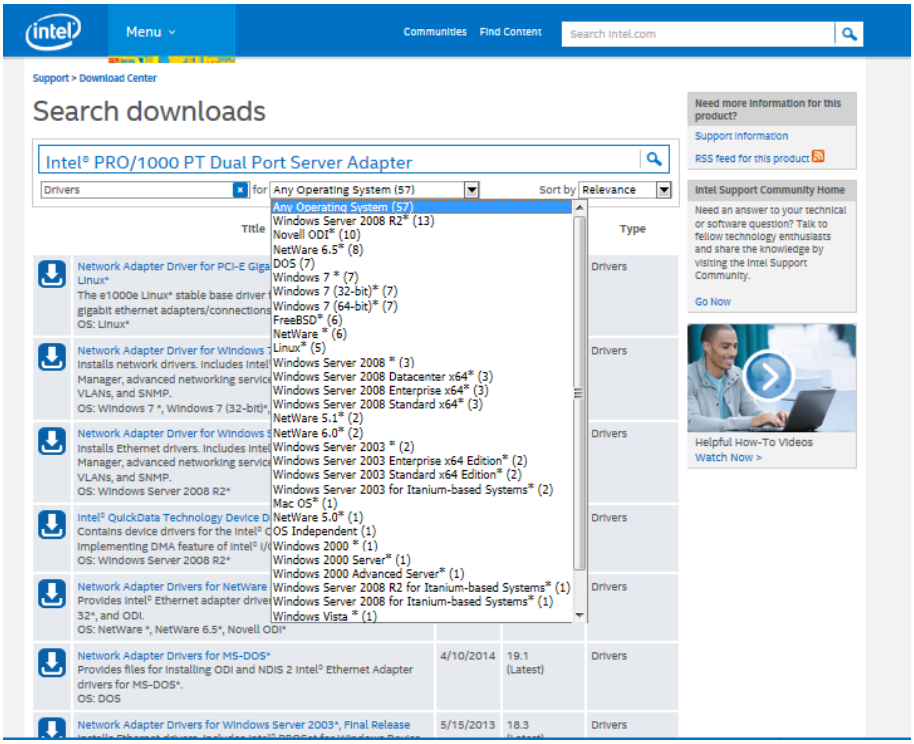
1. Intel NIC driver installation

In Windows 7 or Windows 8.1 OS, when a NIC is installed and the PC is started, the default driver supported by the Microsoft OS may be automatically installed. The Microsoft driver does not have the "Teaming" function needed for the GigE Vision Link Aggregate Method (LAG). Therefore, in order to make the "Teaming" function available, it is necessary to install the Intel NIC driver. Please note that if Intel ceases support for this driver, "Teaming" may not be available on the latest OS. The following describes the procedure to install the Intel NIC driver.

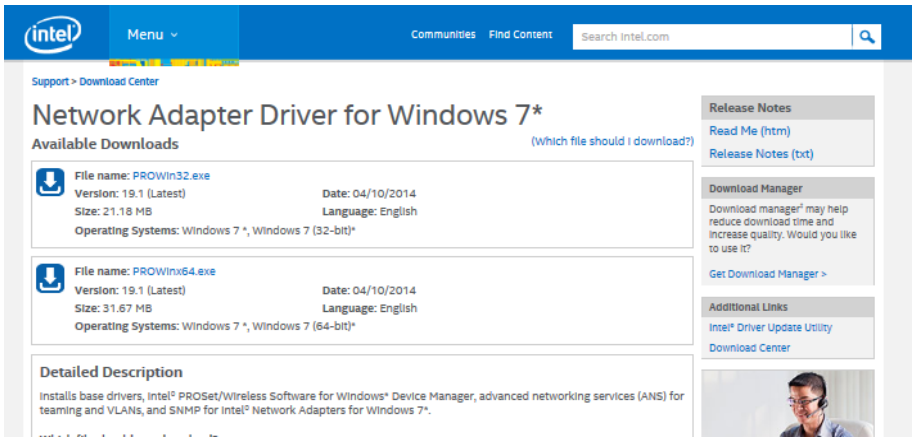


Navigate to the Intel web site and open the Drivers & Software page. Select the appropriate items from the drop-down selection lists.
In this example, select Network Connectivity, Intel Server Adapters, Intel PRO1000 PT Dual Port Server Adapter and Drivers & Software. Then click the "Find" button.

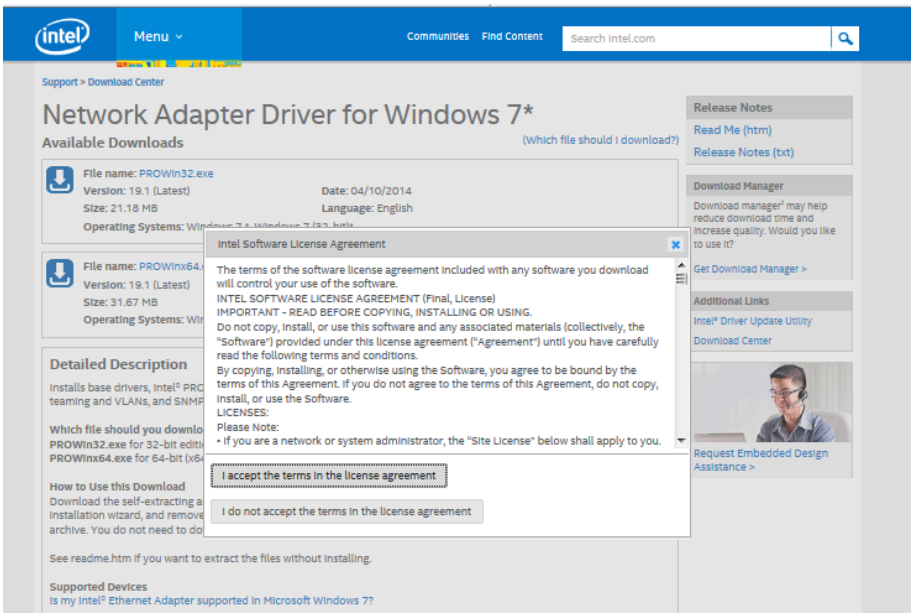
On the Search Downloads page, select your operating system -- in this case Windows 7.



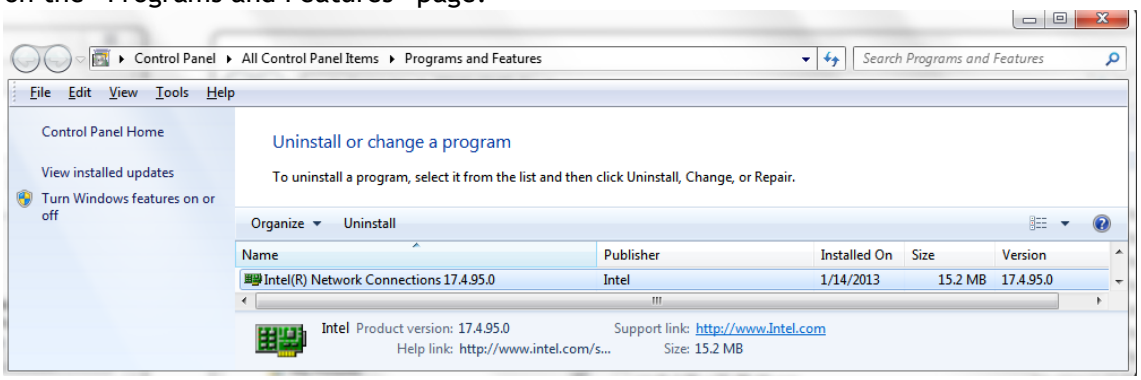
Select either 32-bit or 64-bit version.



After downloading the driver, double-click PROWin32.exe or PROWin64.exe to install the driver.



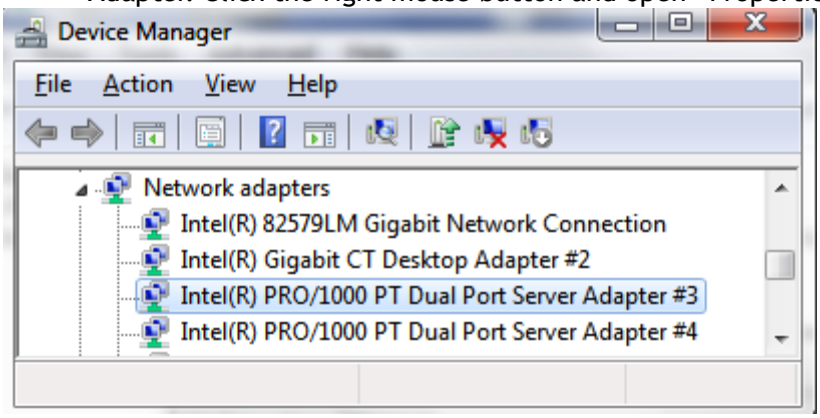
After installing the driver, it is possible to confirm version information about the driver in the listing on the “Programs and Features” page.



2. Setting of NIC properties

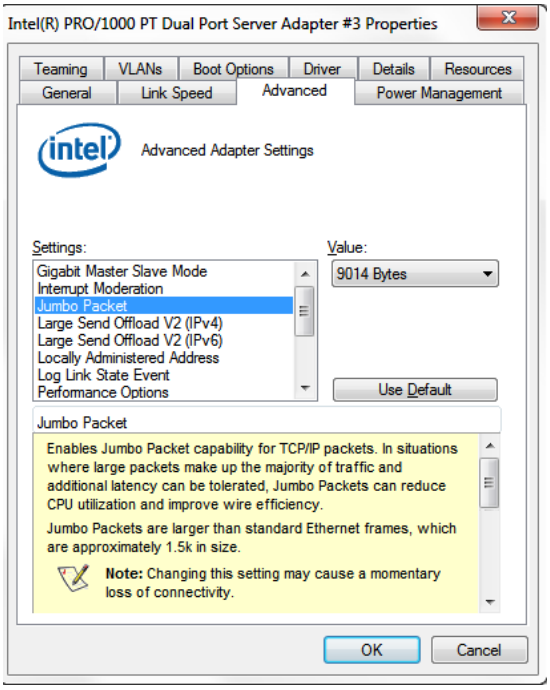
2.1 Settings of each port.

Open the “Device Manager” and find the network adapter, Intel PRO 1000 PT Dual Port Server Adapter. Click the right mouse button and open “Properties”.

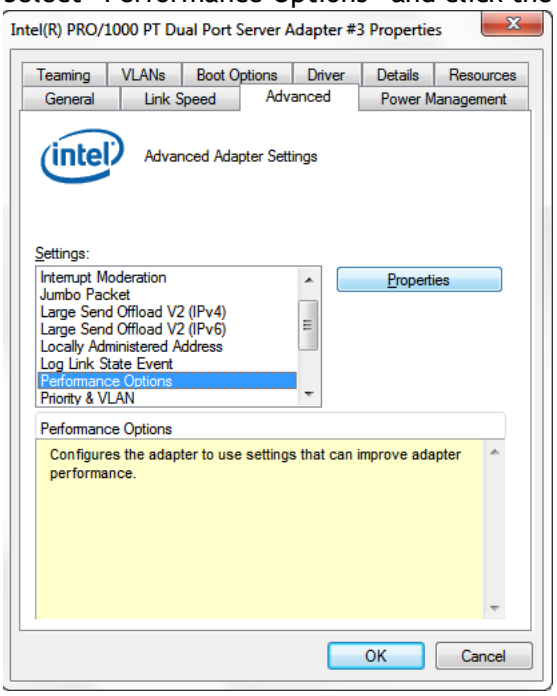


The following settings must be applied to each port. This is especially true for Jumbo Packet and Interrupt Moderation. If the settings for these items remain as default, it will affect when images are captured.

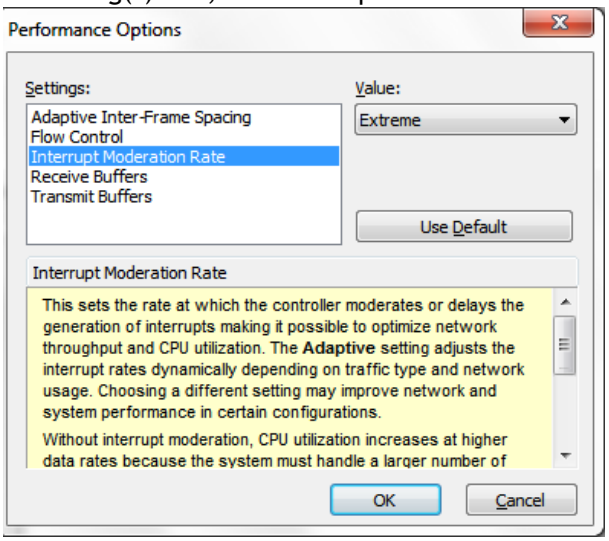
Set Jumbo Frame (Jumbo Packet) to 9014 Bytes.



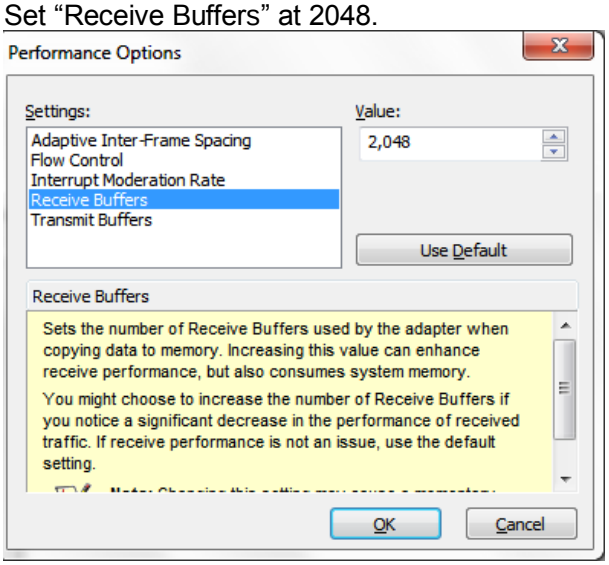
Select “Performance Options” and click the “Properties” button.



In setting(s) box, set “Interrupt Moderation Rate” to “Extreme.”

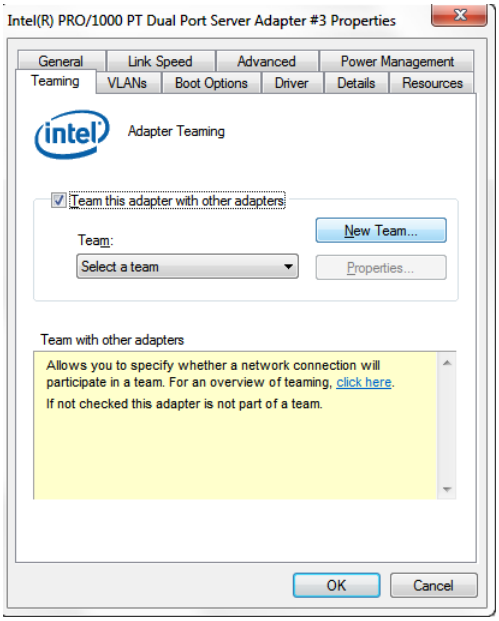


Set “Receive Buffers” at 2048.

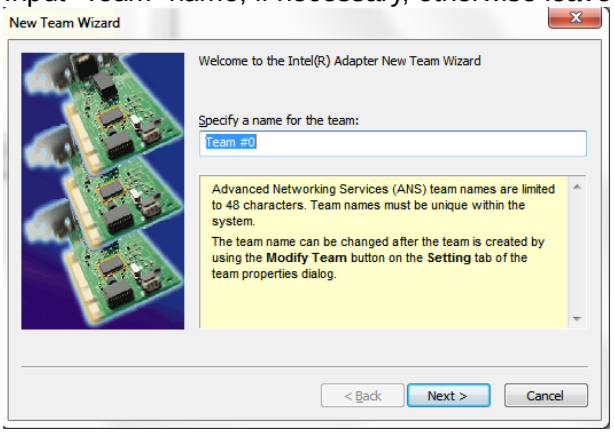


2.2 Settings of “Teaming”

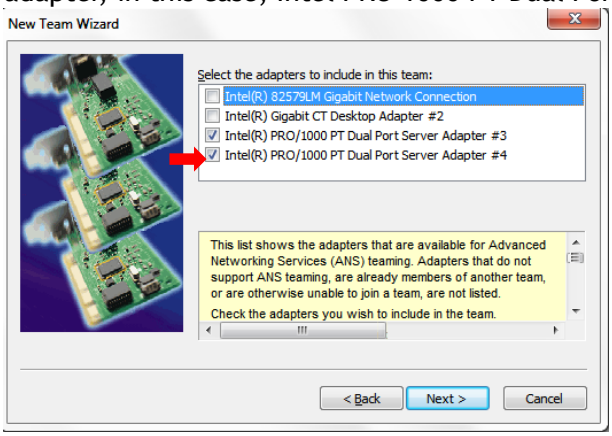
Open “Teaming” tab. Check “Team this adapter with other adapters” and click “New Team” button.



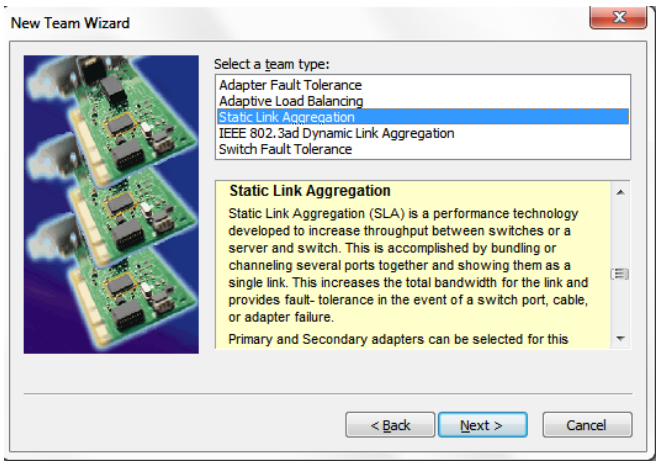
Input “Team” name, if necessary, otherwise leave it as is. Then click “Next”.



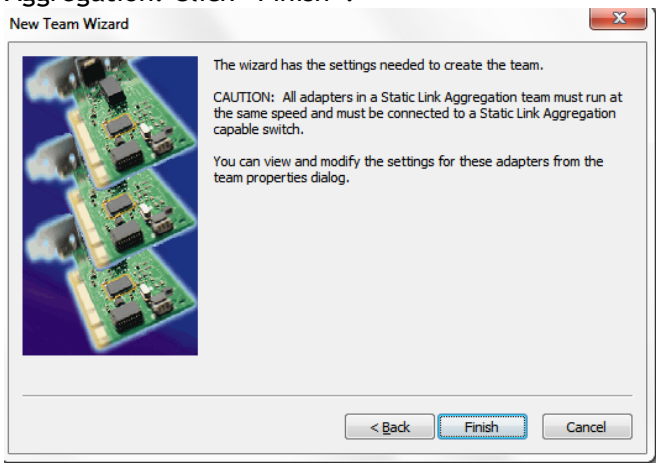
The “Select adapters to include in this team” dialog will open.
The adapter with its properties dialog currently open will already be checked. Check the other adapter, in this case, Intel PRO 1000 PT Dual Port Server Adapter #4. Then click “Next”.



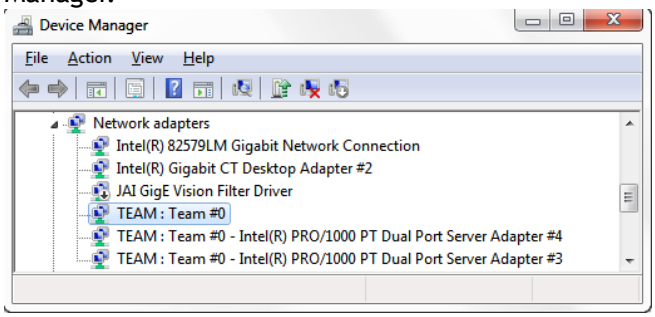
"Team Type Selection" will open. In the SP-5000-GE2, only "Static Link Aggregation" and "IEEE 802.3ad Dynamic Link Aggregation" are available. In this example, "Static Link Aggregation" is selected. Then click "Next".



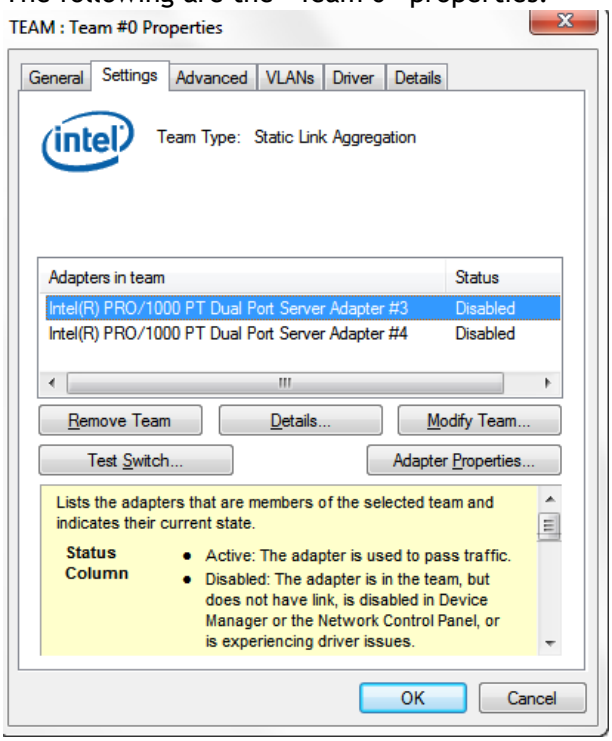
The confirmation message for creating new team will be displayed. In this example, it is Static Link Aggregation. Click "Finish".



When "Teaming" is completed, "Team: Team Number 0" is added to the network adapter in Device Manager.

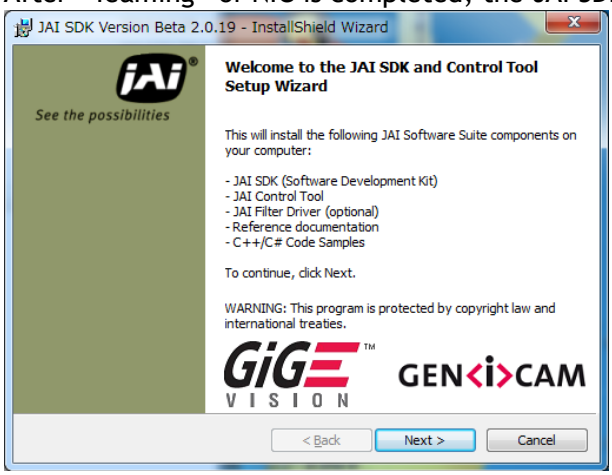


The following are the “Team 0” properties.

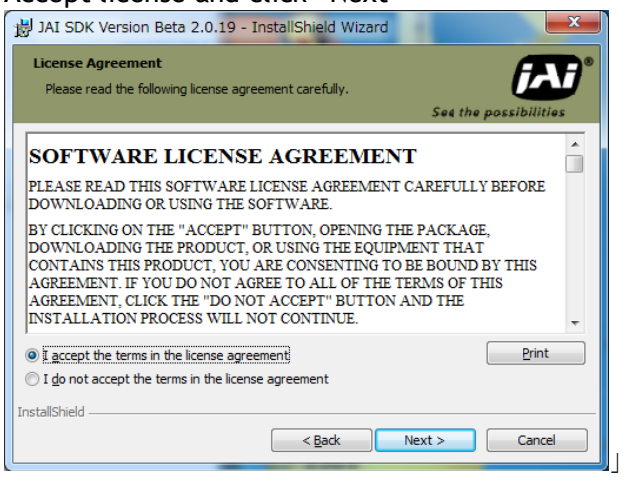


3. JAI SDK Install

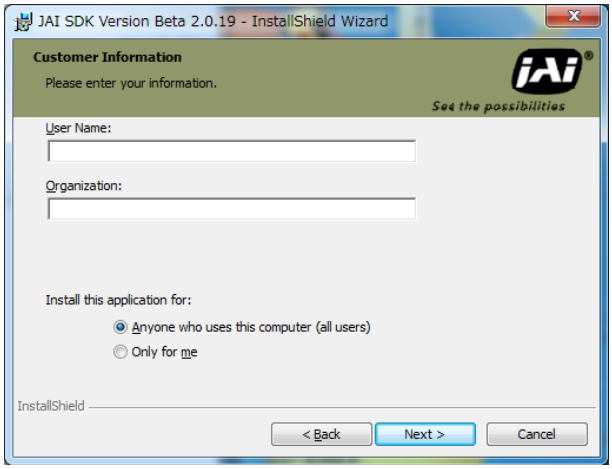
After “Teaming” of NIC is completed, the JAI SDK must be installed.



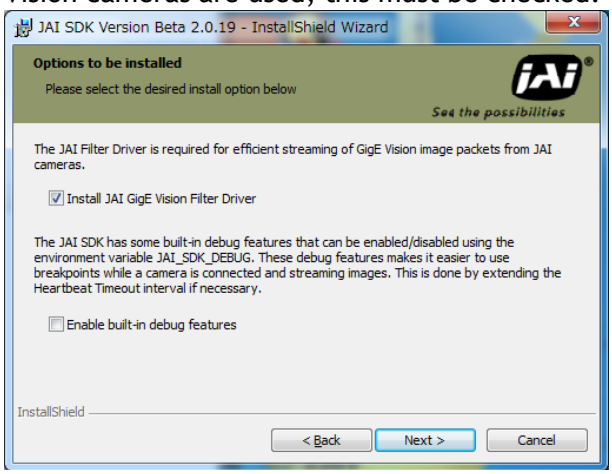
Accept license and click “Next”



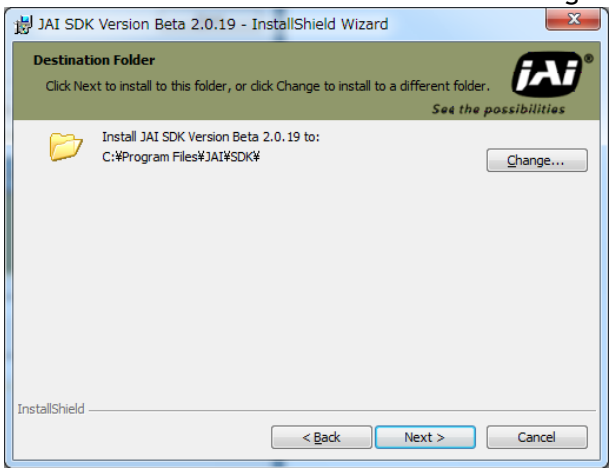
Fill in the fields if needed. Then click “Next”.



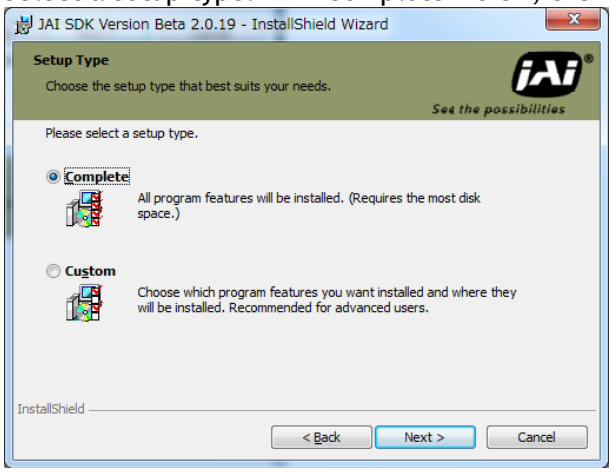
This screen confirms whether or not the JAI GigE Vision Filter Driver is to be installed. When GigE Vision cameras are used, this must be checked.



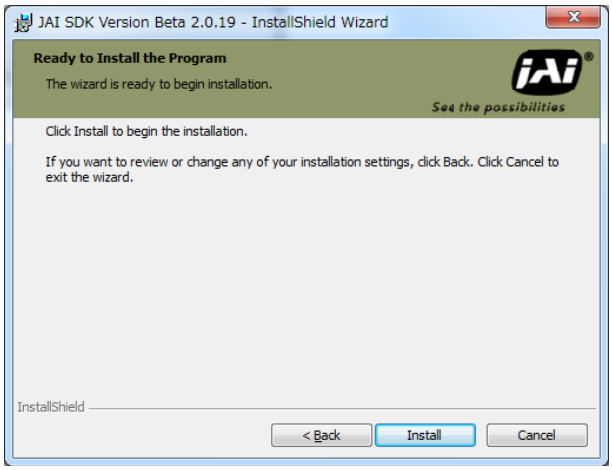
Set the folder to install. If the default setting is OK, just click “Next”.

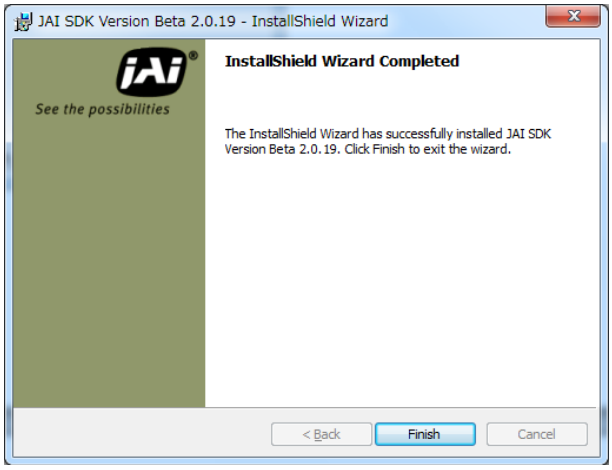


Select a setup type. If “Complete” is OK, then click “Next”.

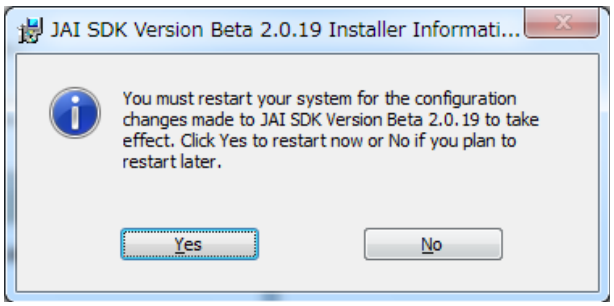


Click the “Install” button to start installation.

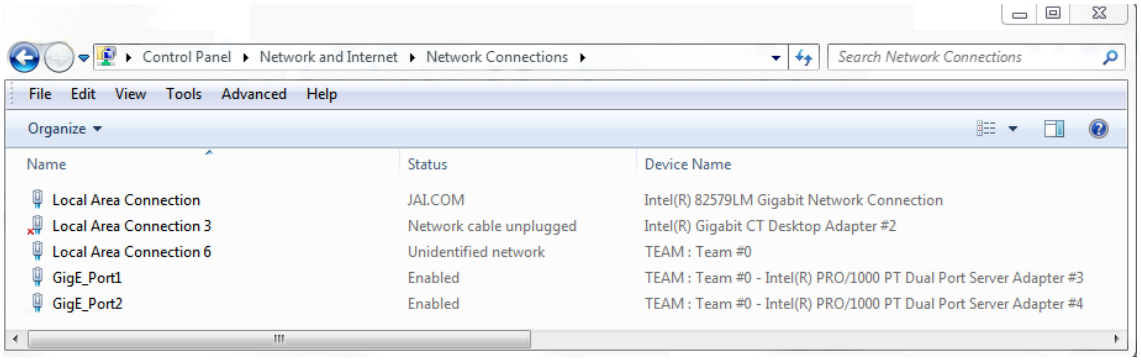




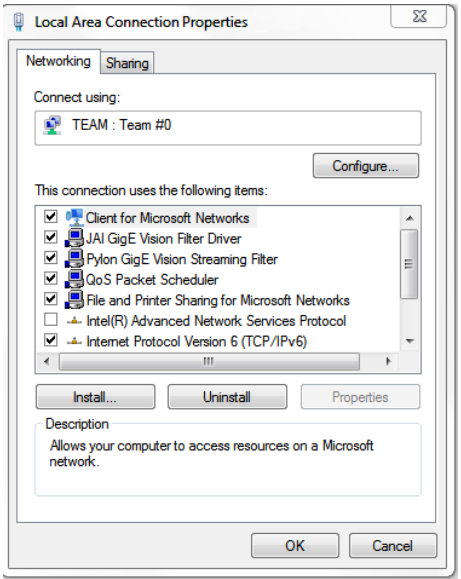
Click “Yes” to restart the PC.

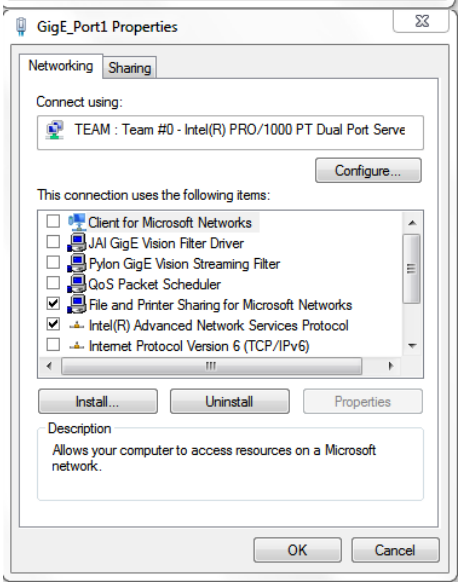


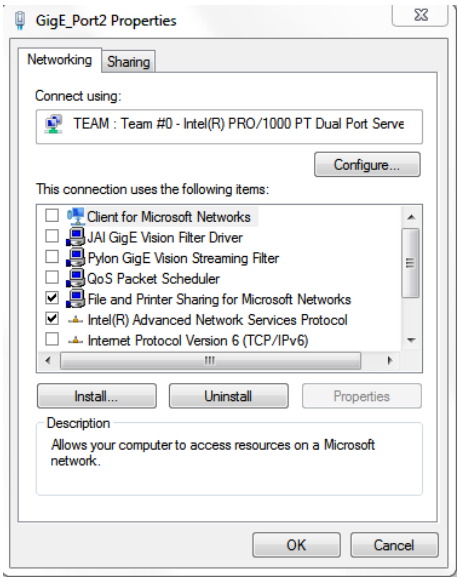
After restarting, check to see that the filter driver is in the local area network.
In the following example, two port names of the Intel PRO 1000 PT Dual Port Server Adapter are re-named. (GigE_Port and Number)
If the team name used the default setting, the ports are automatically named by local area network and number.



In the Properties window of the Local Area Network which is to be Teamed, the JAI GigE Vision Filter Driver is initially checked. After "Teaming," JAI GigE Vision Filter Drivers are not checked in the Properties of Port 1 and Port 2 of the Intel PRO 1000 PT Dual Port Server Adapter Local Area Network.

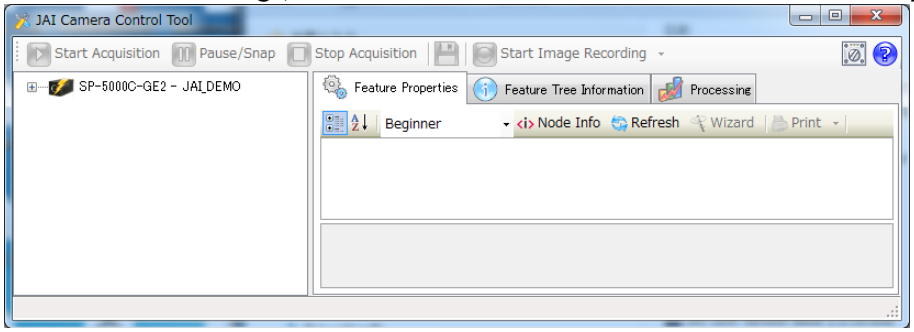




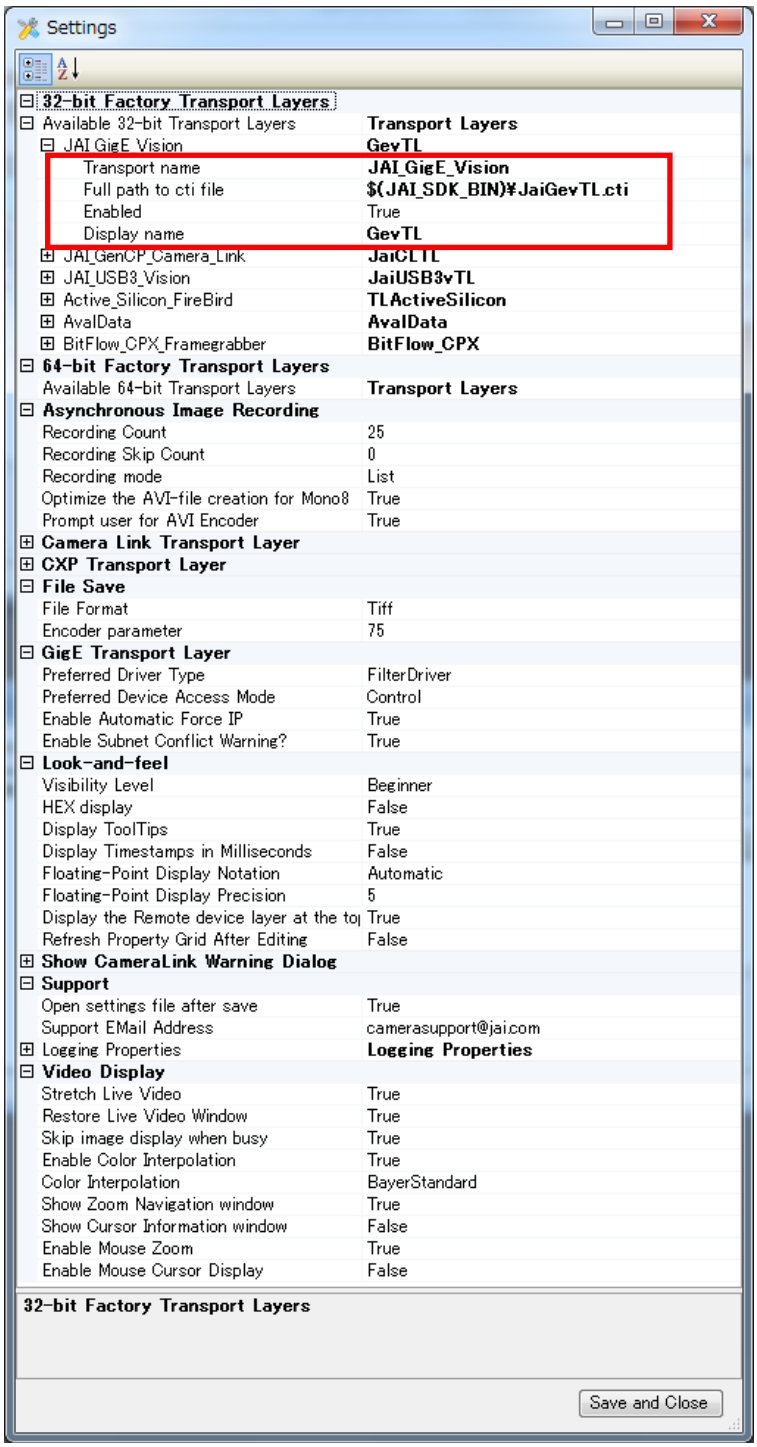


4. Settings of JAI Camera Control Tool

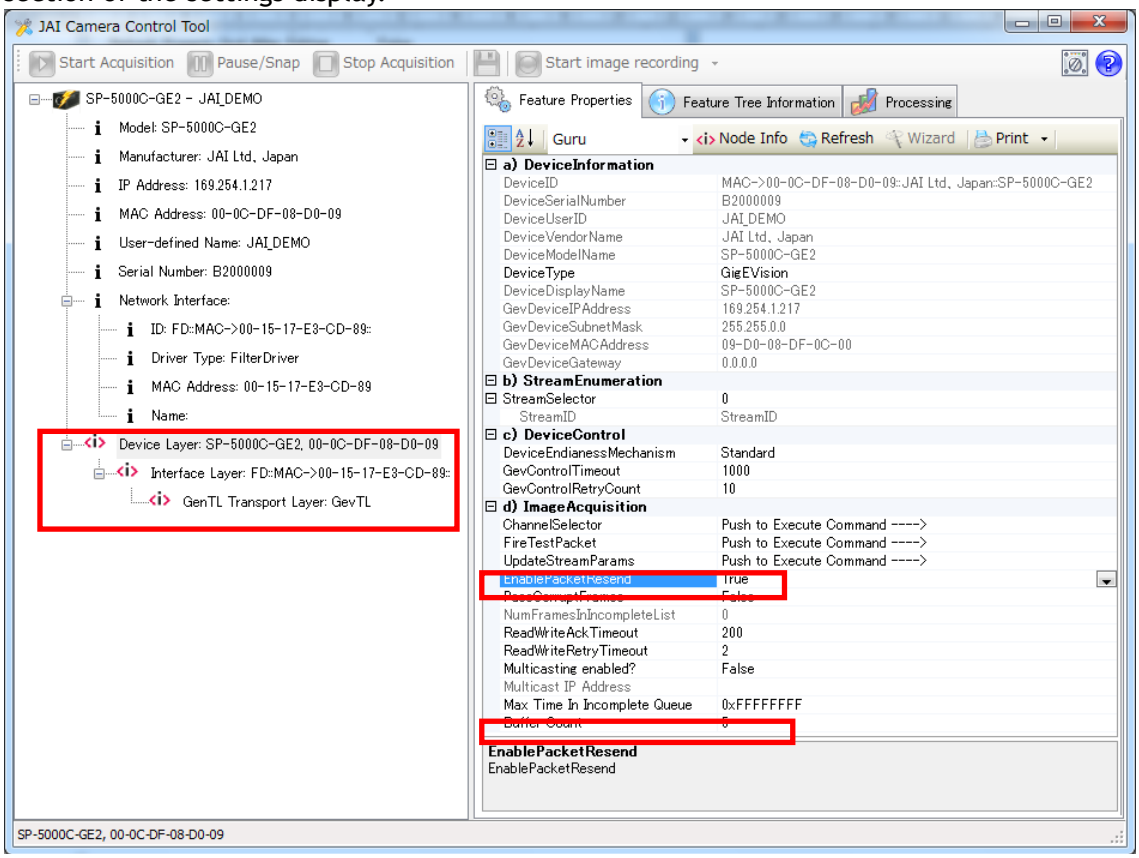
Start JAI Camera Control Tool in Windows Start Menu.
In the default settings, the camera control tool will search automatically for connected cameras.



In JAI SDK 2.0.x, the Settings window is updated with the applicable camera interface settings.



In JAI SDK 2.0.x, “Buffer Count” and “Enable Packet Resend” are found under the GenICam (GenTL) settings as a Device Layer property, while they are found in the Settings dialog in the JAI SDK 1.4.1 camera control tool. These settings can be set every time the camera is connected.
To access the settings in SDK 2.0.x, open the selector of the connected camera, and find the Device Layer in the properties tree. Expand the Device Layer node to reveal the GenTL Transport layer under Interface Layer. Buffer Count and Enable Packet Resend are available in the Image Acquisition section of the settings display.



5.2 Connectors and pin assignment

5.2.1 Output connector for Gigabit Ethernet

Type : RJ-45

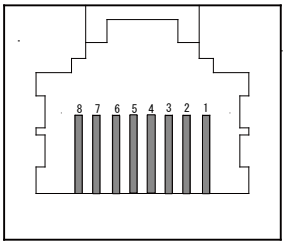


Fig.3 RJ-45 connector

The digital output signals follow the Gigabit Ethernet interface using an RJ-45 conforming connector. The following table shows pin configuration.

Table 4. RJ-45 pin configuration

Pin No.	Input /Output	Description
1	In/Out	MX1+ (DA+)
2	In/Out	MX1- (DA-)
3	In/Out	MX2+ (DB+)
4	In/Out	MX3+ (DC+)
5	In/Out	MX3- (DC-)
6	In/Out	MX2- (DB-)
7	In/Out	MX4+ (DD+)
8	In/Out	MX4- (DD-)

5.2.2 12-Pin connector

Type: HR-10A-10R-12PB(72) Hirose male or equivalent.

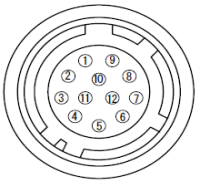


Fig.4 12-pin connector

Table 5. Hirose 12P pin assignment

Pin no.	I/O	Signal	Remarks
1		GND	
2	I	DC in	+12V ~ +24V
3	I	Opto in2-	Line6
4	I	Opto in2+	
5	I	Opto in1-	Line5
6	I	Opto in1+	
7	O	Opto out1-	Line2
8	O	Opto out1+	
9	O	Opto out2-	Line3
10	O	Opto out2+	
11	I	DC in	+12V ~ +24V
12		GND	

5.2.3 AUX Standard Hirose 10-Pin connector

5.2.3.1 Figure and pin configuration

Type : HIROSE 10-Pin Connector 3260-10S3(55)

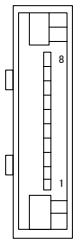


Fig.5 Hirose 10-pin connector

Table 6. Hirose 10P pin assignment (Standard)

No	I/O	Name	Note
1	O	DRIVE IRIS+	Motorized Lens
2	O	DRIVE FOCUS+	Motorized Lens
3	O	DRIVE ZOOM+	Motorized Lens
4	O	COMMON	Motorized Lens
5		GND	
6	O	P-IRIS OUT A+	P-Iris Lens
7	O	P-IRIS OUT A-	P-Iris Lens
8	O	P-IRIS OUT B+	P-Iris Lens
9	O	P-IRIS OUT B-	P-Iris Lens
10	O	GND	

5.2.4 AUX Type 2 HIROSE 10-Pin connector (factory option)

Type: HIROSE 10-Pin Connector 3260-10S3(55)

Table 7. Hirose 10P pin assignment (Option 1)

No	I/O	Name	Note
1	O	Video Signal	Video Iris Lens
2	O	Power DC+12V	Video Iris Lens
3		NC	
4		NC	
5		GND	
6	O	DC IRIS DAMP-	DC Iris
7	O	DC IRIS DAMP+	DC Iris
8	O	DC IRIS DRIVE+	DC Iris
9	O	DC IRIS DRIVE-	DC Iris
10		GND	

5.2.5 AUX Type 3 HIROSE 10-Pin connector (factory option)

Type: HIROSE 10-Pin Connector 3260-10S3(55)

Table 8. HIROSE 10P pin assignment

No	I/O	Name	Note
1	O	TTL OUT2	Line8
2	O	TTL OUT3	Line9
3	I	TTL_IN2	Line10
4		NC	
5		GND	
6	I	LVDS_IN1+	Line11
7	I	LVDS_IN1-	
8		NC	
9		GND	
10		GND	

5.3 Digital IN/OUT interface

In the SP-5000M-GE2 and SP-5000C-GE2, the digital IN/OUT capability in the software control tool can assign the necessary signals needed for the system.

5.3.1 Line Selector

In the Line Selector, the following input and output signals can be assigned.

Table 9. Line selector

Line Selector item	Description
Line 2 Opt 1 Out	Opt 1 output from # and #8 pins of DC In/Trigger 12-Pin on the rear
Line 3 Opt 2 Out	Opt Out 2 output from #9 & 10 pins of DC In/Trigger 12-Pin on the rear
Line 8 TTL 2 Out	TTL 2 output from #1pin “AUX” HIROSE 10-Pin on the rear (Factory option)
Line 9 TTL 3 Out	TTL 3 output from #2pin “AUX” HIROSE 10-Pin on the rear (Factory option)
NAND 0 In 1	First input at NAND first gate in GPIO
NAND 0 In 2	Second input at NAND first gate in GPIO
NAND 1 In 1	First input at NAND second gate in GPIO
NAND 1 in 2	Second input at NAND second gate in GPIO

Note1: Select and connect the line source signal against the item selected in the line selector.
Note2: Line 8 and 9 are available if AUX Type 3 (Optional configuration) is selected.

5.3.2 Line Source

Line source signal can be selected from the following table to connect it to the line item which is selected in the line selector.

Table 10. Line Source

Line Source item	Description
Low	Connect Low Level signal to line item selected in Line Selector, **Default setting**
High	Connect High Level signal to line item selected in Line Selector
Frame Trigger Wait	Connect Frame Trigger Wait signal to line item selected in Line Selector
Frame Active	Connect Frame Active signal to line item selected in Line Selector
Acquisition Trigger Wait	Connect Acquisition Trigger Wait signal to line item selected in Line Selector
Acquisition Active	Connect Acquisition Active signal to line item selected in Line Selector
Exposure Active	Connect Exposure Active signal to line item selected in Line Selector
FVAL	Connect FVAL signal to line item selected in Line Selector
LVAL	Connect LVAL signal to line item selected in Line Selector
PulseGenerator0 Out	Connect Pulse Generator 0 signal to line item selected in Line Selector
PulseGenerator1 Out	Connect Pulse Generator 1 signal to line item selected in Line Selector
PulseGenerator2 Out	Connect Pulse Generator 2 signal to line item selected in Line Selector
PulseGenerator3 Out	Connect Pulse Generator 3 signal to line item selected in Line Selector
User output 0	Connect User Output 0 signal to line item selected in Line Selector
User output 1	Connect User Output 1 signal to line item selected in Line Selector
User output 2	Connect User Output 2 signal to line item selected in Line Selector
User output 3	Connect User Output 3 signal to line item selected in Line Selector
Line 5 Opt 1 In	Connect Opt 1 In signal to line 5 in Line Selector
Line 6 Opt 2 In	Connect Opt 2 In signal to line 6 in Line Selector
NAND 0 Out	Connect NAND 0 signal to line item selected in Line Selector
NAND 1 Out	Connect NAND 1 signal to line item selected in Line Selector
Line 10 TTL 2 In	Connect TTL 2 In signal to Line 10
Line 11 LVDS 1 In	Connect LVDS 1 In signal to Line 11

Note1: As for LVAL, some line items cannot be connected. Refer to "5.3.7.2 GPIO matrix table"

Note2: Line 10 and 11 are available if AYX Type 3 (Optional configuration) is selected.

5.3.3 Line Mode

Indicates the status of the interface, input or output.

5.3.4 Line Inverter

Sets the polarity of the selected input or output.

5.3.5 Line Status

Indicates the status of the selected signal, input or output (True=High or False=Low)

5.3.6 Line Format

Controls the format of the line item selected in Line Selector.
(No Connect, TTL, LVDS, Opt Coupled)

5.3.7 GPIO

This is a general interface for input and output and controls input and output for trigger signals or valid signals and pulse generator. By using this interface, you can control an external light source, make a delayed function to input a trigger signal or make a precise exposure control with PWC trigger.

5.3.7.1 Basic block diagram

Note: Items written in blue are available only if Type 3 is selected for AUX connector.

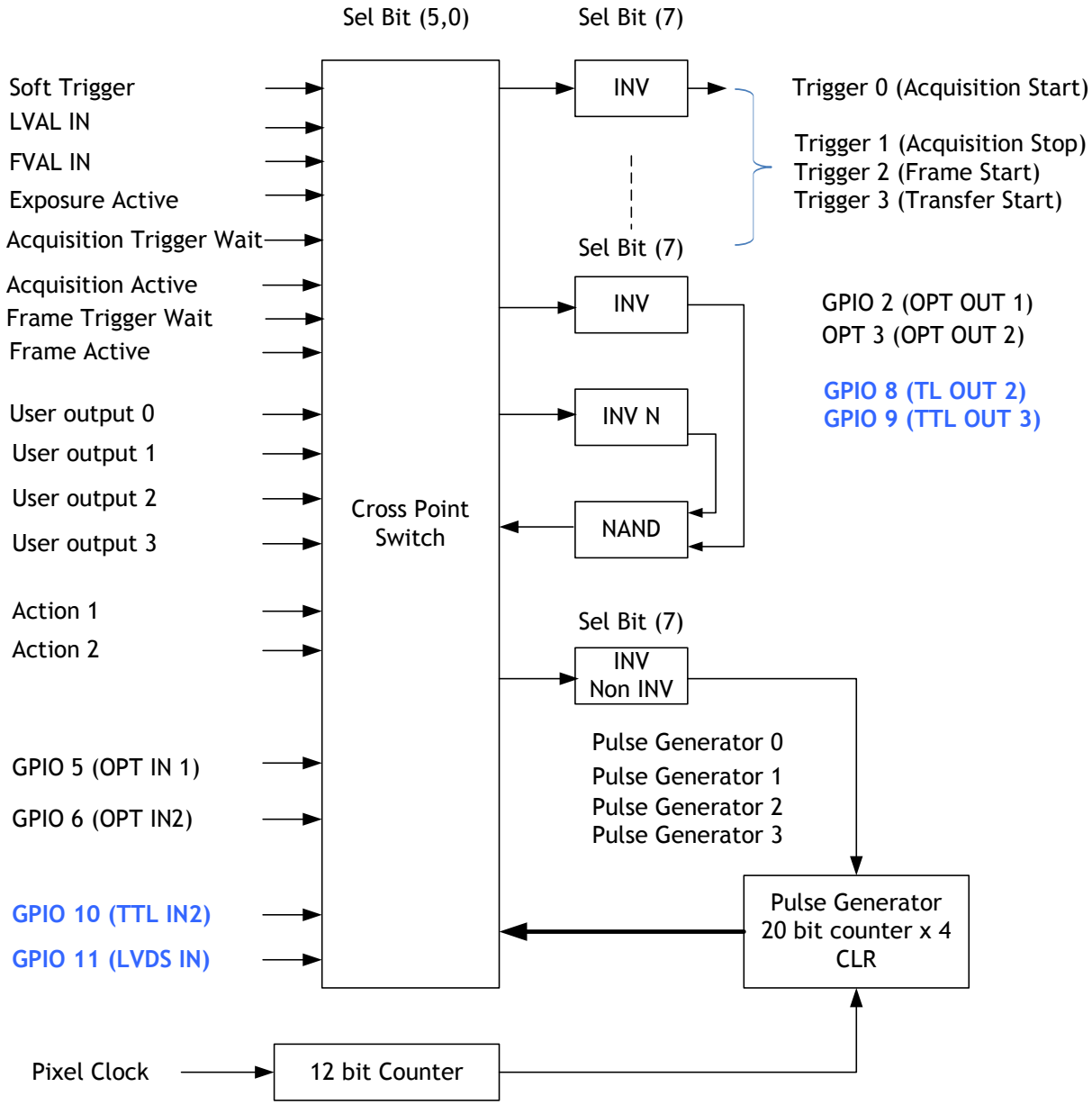

Sel Bit (5,0)
Sel Bit (7)
Soft Trigger
LVAL IN
FVAL IN
Exposure Active
Acquisition Trigger Wait
Acquisition Active
Frame Trigger Wait
Frame Active
User output 0
User output 1
User output 2
User output 3
Action 1
Action 2
GPIO 5 (OPT IN 1)
GPIO 6 (OPT IN2)
GPIO 10 (TTL IN2)
GPIO 11 (LVDS IN)
Cross Point Switch
INV
Trigger 0 (Acquisition Start)
Trigger 1 (Acquisition Stop)
Trigger 2 (Frame Start)
Trigger 3 (Transfer Start)
Sel Bit (7)
INV
GPIO 2 (OPT OUT 1)
OPT 3 (OPT OUT 2)
INV N
GPIO 8 (TL OUT 2)
GPIO 9 (TTL OUT 3)
NAND
Sel Bit (7)
INV
Non INV
Pulse Generator 0
Pulse Generator 1
Pulse Generator 2
Pulse Generator 3
Pulse Generator
20 bit counter x 4
CLR
Pixel Clock
12 bit Counter

Fig. 6 GPIO

5.3.7.2 IN and OUT matrix table

The following table shows the input and output matrix table.

Table 11. GPIO IN and OUT matrix table

Selector (Cross point switch output) / Source signal (Cross point switch input)	Trigger Selector			Line Selector								Pulse Generator Selector				
	Acquisition Start	Acquisition Stop	Frame Start	Line 2 - 12P OPT Out 1	Line 3 - 12P Opt Out 2	Line 8 - TTL 2 Out	Line 9 - TTL 3 Out	NAND 1 In 1	NAND 1 In 2	NAND 2 In 1	NAND 2 In 2	Pulse Generator 0	Pulse Generator 1	Pulse Generator 2	Pulse Generator 3	
LOW	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
HIGH	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
Line 5 - 12P OPT 1 In	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
Line 6 - 12P OPT 2 In	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
NAND 1 Out 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
NAND 2 Out 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
Pulse Generator 0	O	O	O	O	O	O	O	O	O	O	O	×	O	O	O	
Pulse Generator 1	O	O	O	O	O	O	O	O	O	O	O	O	×	O	O	
Pulse Generator 2	O	O	O	O	O	O	O	O	O	O	O	O	O	×	O	
Pulse Generator 3	O	O	O	O	O	O	O	O	O	O	O	O	O	O	×	
User Output 0	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
User Output 1	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
User Output 2	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
User Output 3	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
Software Trigger	O	O	O	×	×	×	×	O	O	O	O	×	×	×	×	
Action 1	O	O	O	O	O	O	O	×	×	×	×	O	O	O	O	
Action 2	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
FVAL	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
LVAL	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Exposure Active	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Acquisition Trigger Wait	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Acquisition Active	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Frame Trigger Wait	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Frame Active	×	×	×	O	O	O	O	O	O	O	O	O	O	O	O	
Line 10 - TTL 2 In	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	Extension GPIO Connection
Line 11 - LVDS 1 In	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	
	Trigger Source			Line Source								Pulse Generator Clear Source				

Note: As for Line 8, Line 9, Line 10 and Line 11 are available if AUX Type 3 is used for AUX connector configuration.

5.4 Optical Interface

SP-5000-GE2 is equipped with opto-isolated inputs and outputs, providing galvanic separation between the camera's inputs/outputs and peripheral equipment.
In addition to galvanic separation, the opto-isolated inputs and outputs can cope with a wide range of voltages; the voltage range for inputs is +3.3V to +24V DC whereas outputs will handle +5V to +24V DC.
The following drawing is the concept of photo coupler

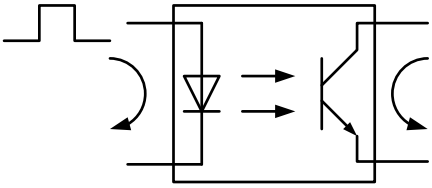


Fig.7 Photo coupler

5.4.1 Recommended External Input circuit diagram for customer

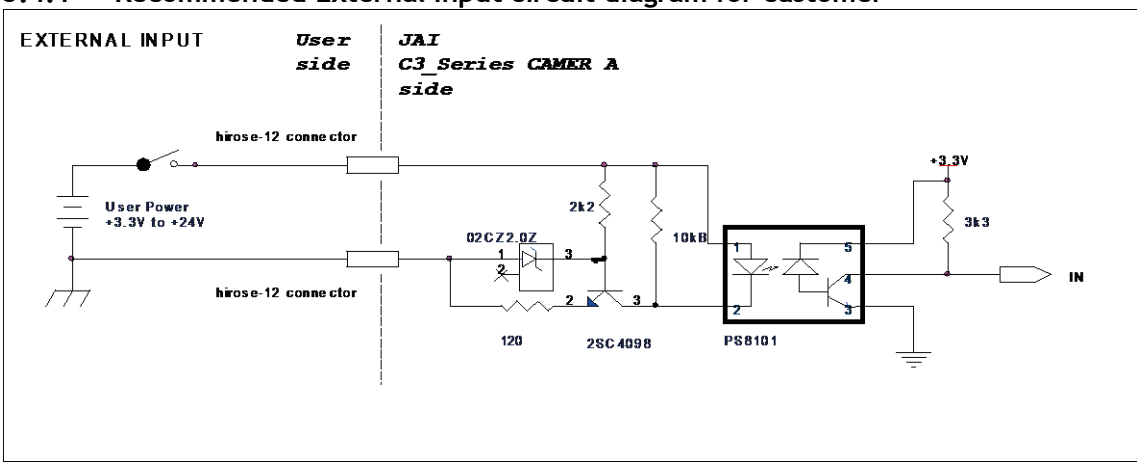


Fig.8 Example of external input circuit

5.4.2 Recommended External Output circuit diagram for customer

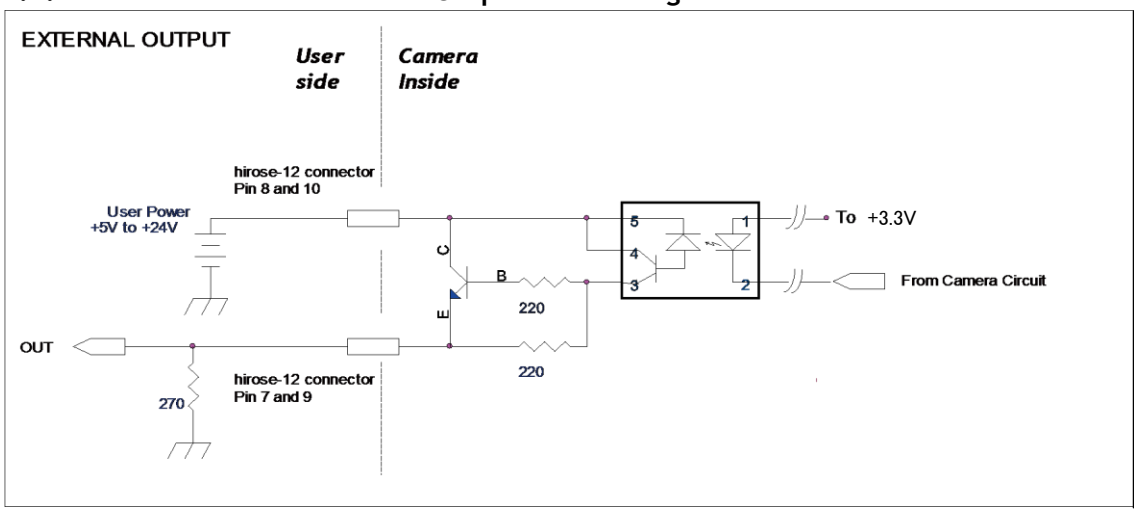
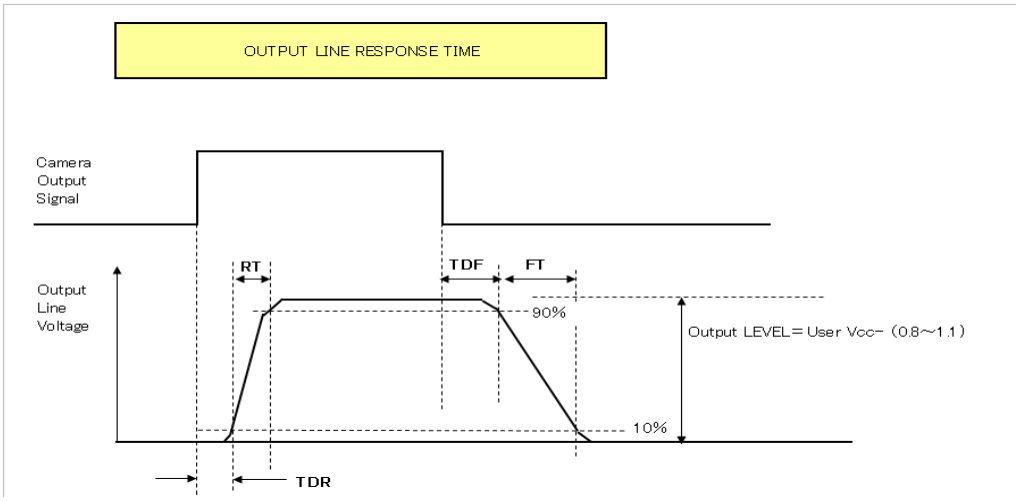


Fig.9 Example of external output circuit

5.4.3 Characteristics of optical interface

The relationship of the input signal to the output signal through the optical interface is as follows.



270Ω	User Power (VCC)			
	3.3V	5V	12V	24V
Time Delay Rise TDR (us)	0.54	0.54	0.62	0.68
Rise Time RT (us)	1.2	1.2	2	3
Time Delay Fall TDF (us)	1.5	1.5	2.4	2.1
Fall Time FT (us)	3.6	3.4	4.5	6.8

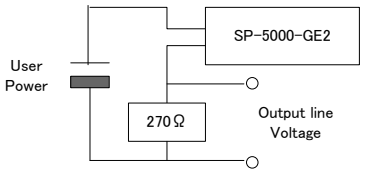


Fig.10 Optical interface characteristics

5.5 Pulse Generator

The SP-5000-GE2 has a frequency divider using the pixel clock as the basic clock and four pulse generators. In each Pulse Generator, various Clear settings are connected to GPIO.
The following shows Pulse Generator default settings.

Table12. Pulse Generator default settings

Display Name	Value							
Clock Pre-scaler	1							
Pulse Generator Selector	Pulse Generator							
	Length	Start Point	End Point	Repeat Count	Clear Source	Clear Inverter	Clear Activation	Clear Sync Mode
- Pulse Generator 0	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 1	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 2	1	0	1	0	Off	True	Off	Async Mode
- Pulse Generator 3	1	0	1	0	Off	True	Off	Async Mode

Note: When Pulse Generator Repeat Count is set to “0”, the camera is operating in Free Running mode.
However, based on the above default setting, Length=1, Start Point=0 and End Point=1, Pulse Generator stops at High output. Therefore, if Start Point=0 and End Point=1 are configured, Length should be “2” as the minimum active width.

5.5.1 Clock Pre-scaler

Clock pre-scaler (Divide Value) can set the dividing value of the frequency divider (12-bit length) and the pixel clock is used for this. Four built-in pulse generators work by the same clock. In the SP-5000-GE2, the pixel clock is set at 48 MHz.

5.5.2 Pulse Generator Selector

This is where you select one of the 4 pulse generators in order to set or modify its parameters.

Table13. Pulse Generator setting

Trigger Selector item	Description
Pulse Generator 0	If Pulse Generator 0 is selected, Length Start Point, End Point, Repeat Count, Clear Source, Clear Inverter Clear Activation and Clear Sync Mode of pulse generator 0 are displayed under the selector.
Pulse Generator 1	If Pulse Generator 1 is selected, Length Start Point, End Point, Repeat Count, Clear Source, Clear Inverter Clear Activation and Clear Sync Mode of pulse generator 1 are displayed under the selector.
Pulse Generator 2	If Pulse Generator 2 is selected, Length Start Point, End Point, Repeat Count, Clear Source, Clear Inverter Clear Activation and Clear Sync Mode of pulse generator 2 are displayed under the selector.
Pulse Generator 3	If Pulse Generator 3 is selected, Length Start Point, End Point, Repeat Count, Clear Source, Clear Inverter Clear Activation and Clear Sync Mode of pulse generator 3 are displayed under the selector.

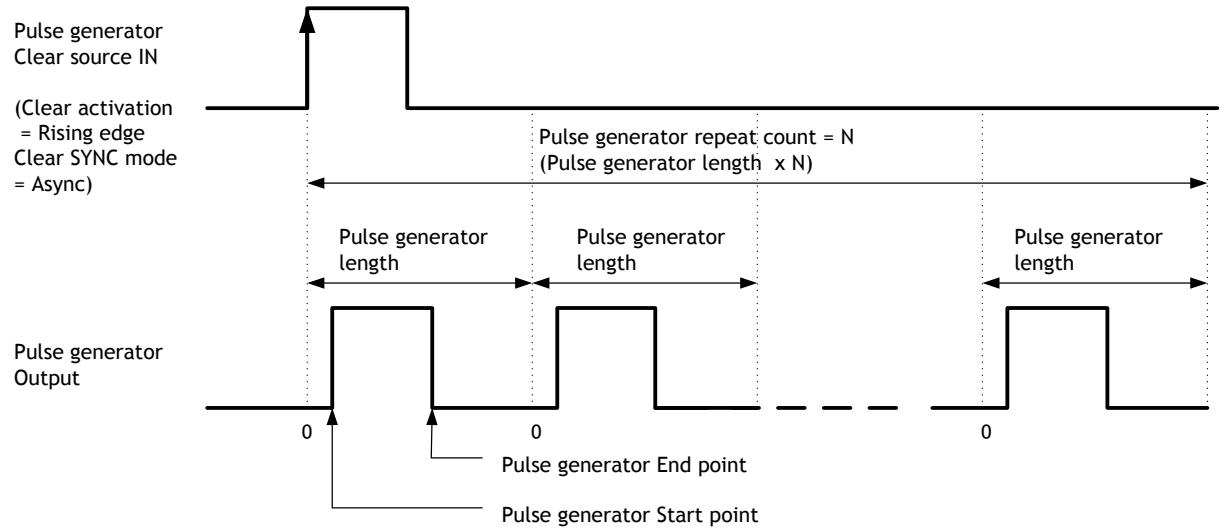


Fig.11 Pulse Generator Pulse construction

5.5.3 Pulse Generator Length

Set the counter up value (number of clocks, refer to Table 14) for the selected pulse generator. If Repeat Count value is “0”, and if Pulse Generator Clear signal is not input, the pulse generator generates the pulse repeatedly until reaching this counter up value.

5.5.4 Pulse Generator Start Point

Set the active output start count value for the selected pulse generator.
However, please note that a maximum 1 clock jitter for the clock which is divided in the clock pre-scaler can occur.

5.5.5 Pulse Generator End Point

Set the active output ending count value for the selected pulse generator.

5.5.6 Pulse Generator Repeat Count

Set the repeating number of the pulse for the selected pulse generator. After Trigger Clear signal is input, the pulse generator starts the count set in Repeat Count. Accordingly, an active pulse which has a start point and end point can be output repeatedly.
However, if Repeat Count is set to "0", it works as a Free-Running counter.

5.5.7 Pulse Generator Clear Activation

Set the clear conditions of clear count pulse for the selected pulse generator.

5.5.8 Pulse Generator Clear Sync Mode

Set the count clear method for the selected pulse generator. In the case of Async Mode, if the clear signal is input during the length setting value, the counter will stop counting according to the clear signal input. In the case of Sync Mode, if the clear signal is input during the length setting value, the counter will continue to count until the end of the length setting value and then clear the count. Both modes clear the repeat count when the counter is cleared.

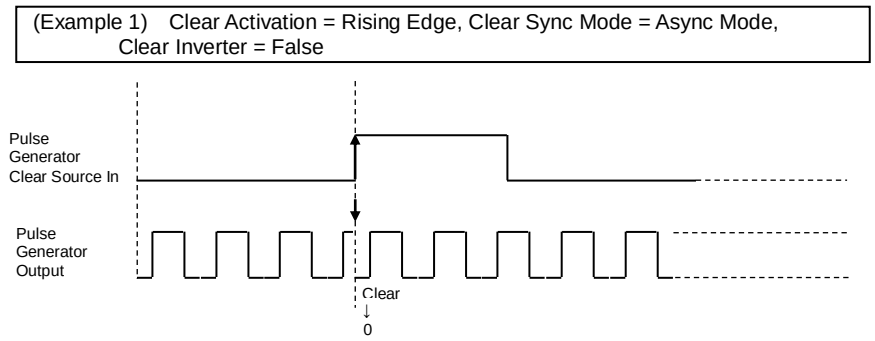


Fig.12 Counter clear in Async mode

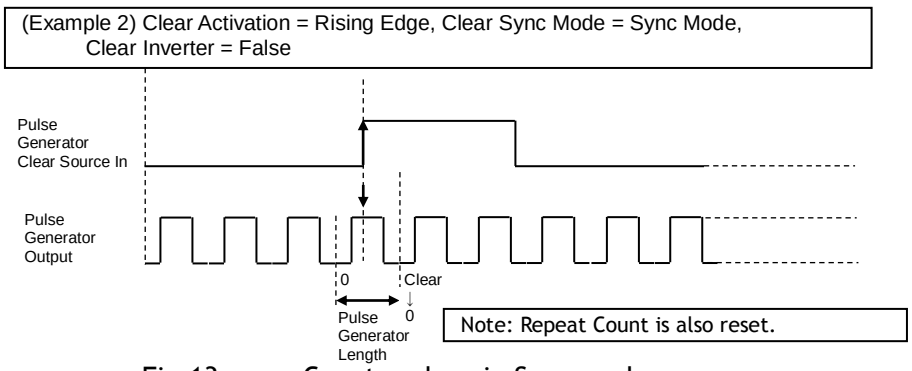


Fig.13 Counter clear in Sync mode

5.5.9 Pulse Generator Clear Source

The following clear source can be selected as the pulse generator clear signal.

Table14. Pulse generator clear source

Pulse Generator Clear Source item	Description
Low	Connect Low level signal to Clear Source for the selected pulse generator. **Default setting**
High	Connect High level signal to Clear Source for the selected pulse generator.
Frame Trigger Wait	Connect Frame Trigger Wait signal to Clear Source for the selected pulse generator.
Frame Active	Connect Frame Active signal to Clear Source for the selected pulse generator.
Exposure Active	Connect Exposure Active signal to Clear Source for the selected pulse generator.
Acquisition Trigger wait	Connect Acquisition Trigger Wait signal to Clear Source for the selected pulse generator.
Acquisition Active	Connect Acquisition Active signal to Clear Source for the selected pulse generator.
FVAL	Connect FVAL signal to Clear Source for the selected pulse generator.
LVAL	Connect LVAL signal to Clear Source for the selected pulse generator.
PulseGenerator0 Out	Connect Pulse Generator 0 output to Clear Source for the selected pulse generator.
PulseGenerator1 Out	Connect Pulse Generator 1 output to Clear Source for the selected pulse generator.
PulseGenerator2 Out	Connect Pulse Generator 2 output to Clear Source for the selected pulse generator.
PulseGenerator3 Out	Connect Pulse Generator 3 output to Clear Source for the selected pulse generator.
Action 1	Connect Action 1 input to Clear Source for the selected pulse generator.
Action 2	Connect Action 2 input to Clear Source for the selected pulse generator.
User output0 Out	Connect User output 0 to Clear Source for the selected pulse generator.
User output1 Out	Connect User output 1 to Clear Source for the selected pulse generator.
User output2 Out	Connect User output 2 to Clear Source for the selected pulse generator.
User output3 Out	Connect User output 3 to Clear Source for the selected pulse generator.
Line 5 Opt 1 In	Connect Opt 1 In signal to Clear Source for the selected pulse generator.
Line 6 OPT2 in	Connect Opt 1 In signal to Clear Source for the selected pulse generator.
Nand 0 Out	Connect NAND 0 output signal to Clear Source for the selected pulse generator.
Nand 1 Out	Connect NAND 1 output signal to Clear Source for the selected pulse generator.
Line 10 TTL 2 In	Connect TTL 2 In signal to LINE 10.
Line 11 LVDS 1 In	Connect LVDS 1 In signal to Line 11

Note:
The pulse generator output cannot be used as the clear input to the same pulse generator. Refer to “5.3.7.2. Table 10”.

5.5.10 Pulse Generator Inverter

Clear Source Signal can have polarity inverted.

5.5.11 Pulse Generator Setting Parameters

Table15. Pulse Generator setting parameters

Display Name	Value
Clock Pre-scaler	1 to 4096
Pulse Generator Clock (MHz)	[Pixel Clock:48 MHz]÷[Clock Pre-scaler]
Pulse Generator Selector	- Pulse Generator 0
	- Pulse Generator 1
	- Pulse Generator 2
	- Pulse Generator 3
- Pulse Generator Length	1 to 1048575
- Pulse Generator Length (ms)	（[Clock Source]÷[Clock Pre-scaler]）$^{-1}$ x [Pulse Generator Length]
- Pulse Generator Frequency (Hz)	［Pulse Generator Length (ms)］$^{-1}$
- Pulse Generator Start Point	0 to 1048574
- Pulse Generator Start Point (ms)	（[Clock Source]÷[Clock Pre-scaler]）$^{-1}$ x [Pulse Generator Start Point]
- Pulse Generator End Point	1 to 1048575
- Pulse Generator End Point (ms)	（[Clock Source]÷[Clock Pre-scaler]）$^{-1}$ x [Pulse Generator End Point]
- Pulse Generator pulse-width (ms)	[Pulse Generator End Point (ms)]－[Pulse Generator Start Point (ms)]
- Pulse Generator Repeat Count	0 to 255
- Pulse Generator Clear Activation Clear Mode for the Pulse Generators	- Off
	- High Level
	- Low level
	- Rising Edge
	- Falling Edge
- Pulse Generator Clear Sync Mode	- Async mode
	- Sync mode
- Pulse Generator Clear Source-UserOutput3	- Low
	- High
	- Frame Trigger Wait
	- Frame Active
	- Exposure Active
	- Fval
	- Lval
	- PulseGenerator0
	- PulseGenerator1
	- PulseGenerator2
	- PulseGenerator3
	- UserOutput 0
	- UserOutput 1
	- UserOutput 2
	- UserOutput 3
	- TTL_In1
	- Action 1
	- Action 2
	- Nand0 Out
	- Nand1 Out
	- Line 10 - TTL 2 In
	- Line 11 - LVDS 1 In
- Pulse Generator Inverter(Polarity) Pulse Generator Clear Inverter	- False
	- True

Note:
1. If Pulse Generator Repeat Count is set to “0”, the pulse generator works in Free Running mode.

6. Sensor layout, output format and timing

6.1 Sensor layout

CMOS sensors used in the SP-5000M-GE2 and SP-5000C-GE2 have the following tap and pixel layout.

6.1.1 Monochrome sensor

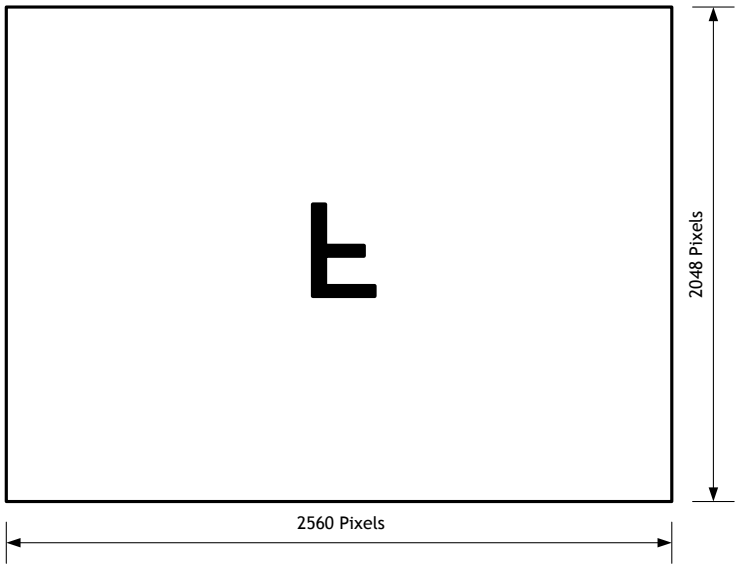


Fig.14 Monochrome sensor layout

6.1.2 Bayer color sensor

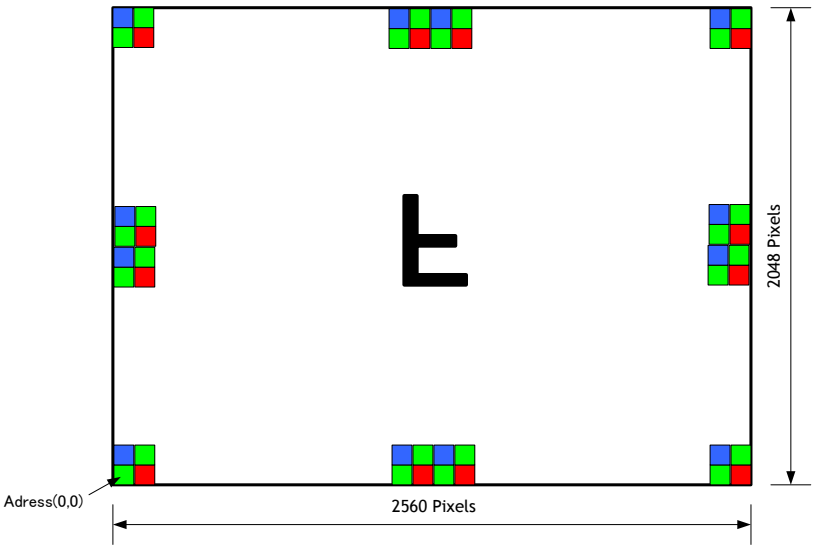


Fig.15 Bayer color sensor layout

6.2. Camera output format

The following table shows the relationship between camera output and sensor readout system.

Camera output format	Sensor readout system	Reference figure
1X-1Y	1-tap readout	6.2.1

Note: The description of camera output format is based on GenICam SFNC Ver.1.5.1.

6.2.1 1X-1Y

1X-1Y is defined in GenICam SFNC Ver.1.5.1 for 1-tap readout and the readout system is the following.

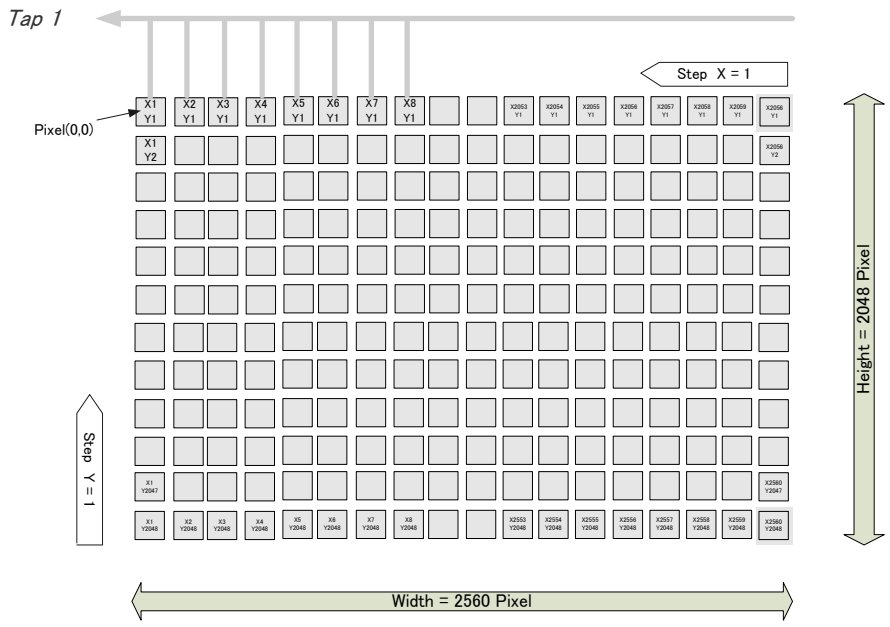


Fig.16 1X – 1Y readout

6.2 GigE Vision Pixel Format

6.2.1 Pixel Format

Model	Supported Pixel Formats
SP-5000M-GE2	Mono8, Mono10, Mono10_Packed
SP-5000C-GE2	BayGR8, BayGR10, BayGR10_PackedRGB8_PACKED, YUV411_PACKED, YUV422_PACKED, YUV444_PACKED

6.2.2 SP-5000M-GE2 Pixel Type

6.2.2.1 GVSP_PIX_MONO8 8-bit output

Y0								Y1								Y2							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

6.2.2.2 GVSP_PIX_MONO10 16-bit output

Y0								Y0								Y1								Y1							
0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X	0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X

6.2.2.3 GVSP_PIX_MONO10PACKED 12-bit output

Y0												Y1												Y2												Y3											
2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9	2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9

6.2.3 SP-5000C-GE2 Pixel Type

6.2.3.1 GVSP_PIX_BAYGR8 8-bit output

odd Line

G0								R1								G2							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

Even Line

B0								G1								B2							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

6.2.3.2 GVSP_PIX_BAYGR10 16-bit output

Odd Line

G0								G0								R1								R1							
0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X	0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X

Even Line

B0								B0								G1								G1							
0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X	0	1	2	3	4	5	6	7	8	9	X	X	X	X	X	X

6.2.3.3 GVSP_PIX_BAYGR10PACKED 12-bit output

Odd Line

G0												R1											
2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9

Even Line

B0												G1											
2	3	4	5	6	7	8	9	0	1	X	X	0	1	X	X	2	3	4	5	6	7	8	9

6.2.3.4 GVSP_PIX_RGB8_PACKED (24-bit)

R0								G0								B0							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

6.2.3.5 GVSP_PIX_YUV411_Packed 12-bit output

4 pixels/6 Bytes

U11								Y11								Y12								V11								Y13								Y14							
0	1	2	3	4	5	6	S	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	S	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

6.2.3.6 GVSP_PIX_YUV422_Packed 16-bit output

2 pixels/4 bytes

U11								Y11								V11								Y12							
0	1	2	3	4	5	6	S	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	S	0	1	2	3	4	5	6	7

6.2.3.7 GVSP_PIX_YUV444_Packed 24-bit output

1 pixel/3 Bytes

U11								Y11								V11							
0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7

6.2.4 PixelSize

Table16. Pixel size

Bit per Pixel	Pixel Format	
	SP-5000M-GE2	SP-5000C-GE2
Bpp8	Mono8	BayerGR8
Bpp12	Mono10Packed	BayerGR10Packed YUV411Packed
Bpp16	Mono10	BayerGR10 YUV422Packed
Bpp24		RGB8Packed YUV444Packed

6.3 Output timing

6.3.1 Horizontal timing

6.3.1.1 Output format: 1X-1Y, Vertical Binning OFF

1 clock = 20.833 ns

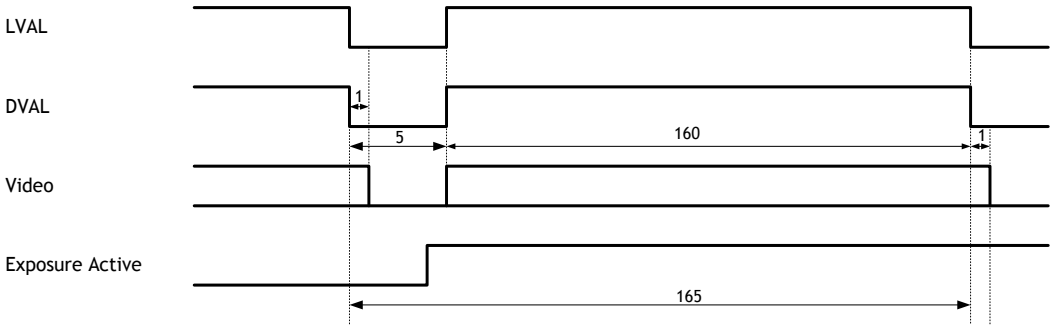


Fig.17 Horizontal Timing (Vertical timing OFF)

6.3.1.2 Output format: 1X-1Y, Vertical Binning ON

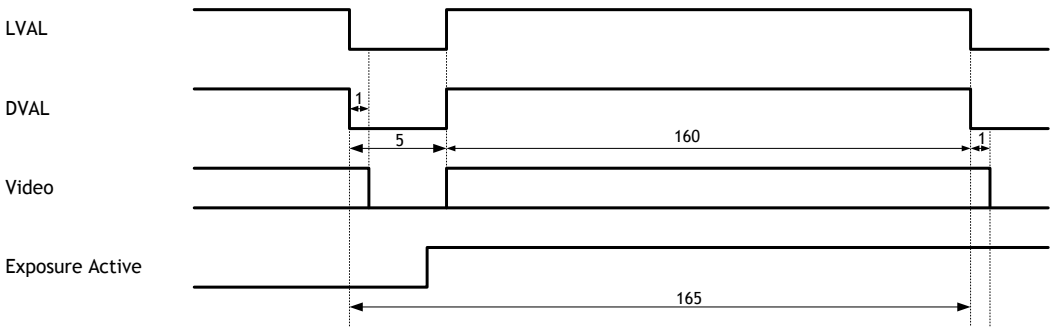


Fig. 18 Horizontal timing (Vertical binning ON)

6.3.2 Vertical timing

6.3.2.1 Output format: 1X-1Y, Vertical Binning OFF

1L = 165 clocks

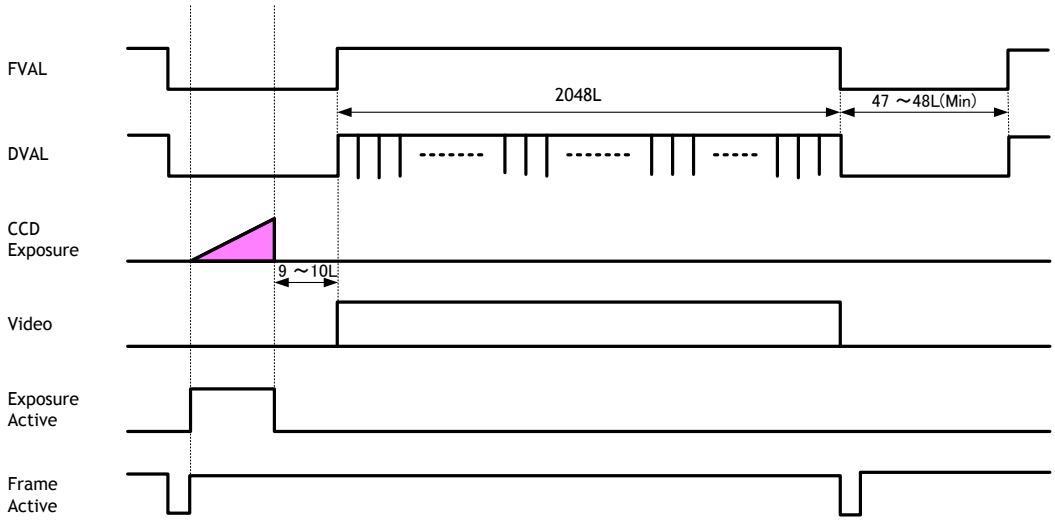


Fig.19 Vertical Timing (Vertical binning OFF)

6.3.2.2 Output format: 1X-1Y, Vertical Binning ON

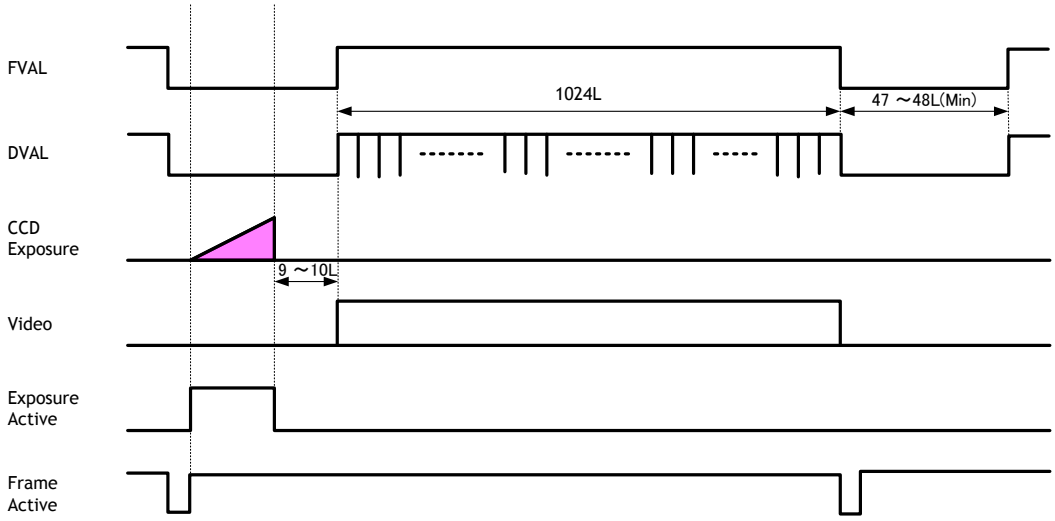


Fig.20 Vertical timing (Vertical binning ON)

6.3.3 ROI (Region Of Interest) setting

In the SP-5000-GE2, a subset of the image can be output by setting Width, Height, Offset-X, and Offset-Y. If the height is decreased, the number of lines read out is decreased and as the result, the frame rate is increased. However, in the horizontal direction, the horizontal frequency is not changed if the width is decreased. In the SP-5000-GE2, the minimum width is “8” and minimum height is “8”.

Setting example (1)
Binning Horizontal = 1
Binning Vertical = 1

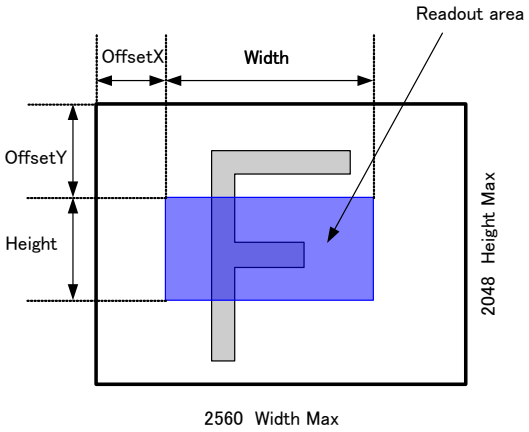


Fig.21 Setting example (No binning)

Setting example (2)
Binning Horizontal = 2
Binning Vertical = 2

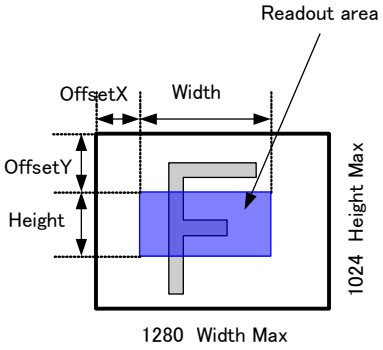


Fig.22 Setting example (Binning)

6.4 Digital output Bit allocation

Table17. Digital output

CCD out		Digital Out		
		8-bit	10-bit	12-bit
Black	0%	8LSB	32LSB	128LSB
Monochrome	100%	222LSB	890LSB	3560LSB
Color				
Monochrome	115%	255LSB	1023LSB	4095LSB
Color				

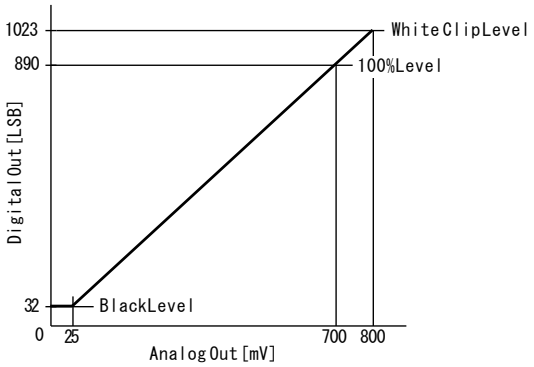


Fig.23 Bit allocation (10-bit)

7. Operating modes

7.1. Acquisition control (change the frame rate)

7.1.1 Acquisition Mode

In the SP-5000-GE2, the following three acquisition modes are available.

Single frame :	One frame can be output by AcqusitionStart command
Multi frames :	The number of frames which is specified in Acquistion Frame Count, are output by AcquisitionStart command
Continuous :	Images are continuously output by AcquisitionStart command until AcqusitionStop command is input.

7.1.1.1 Single Frame operation

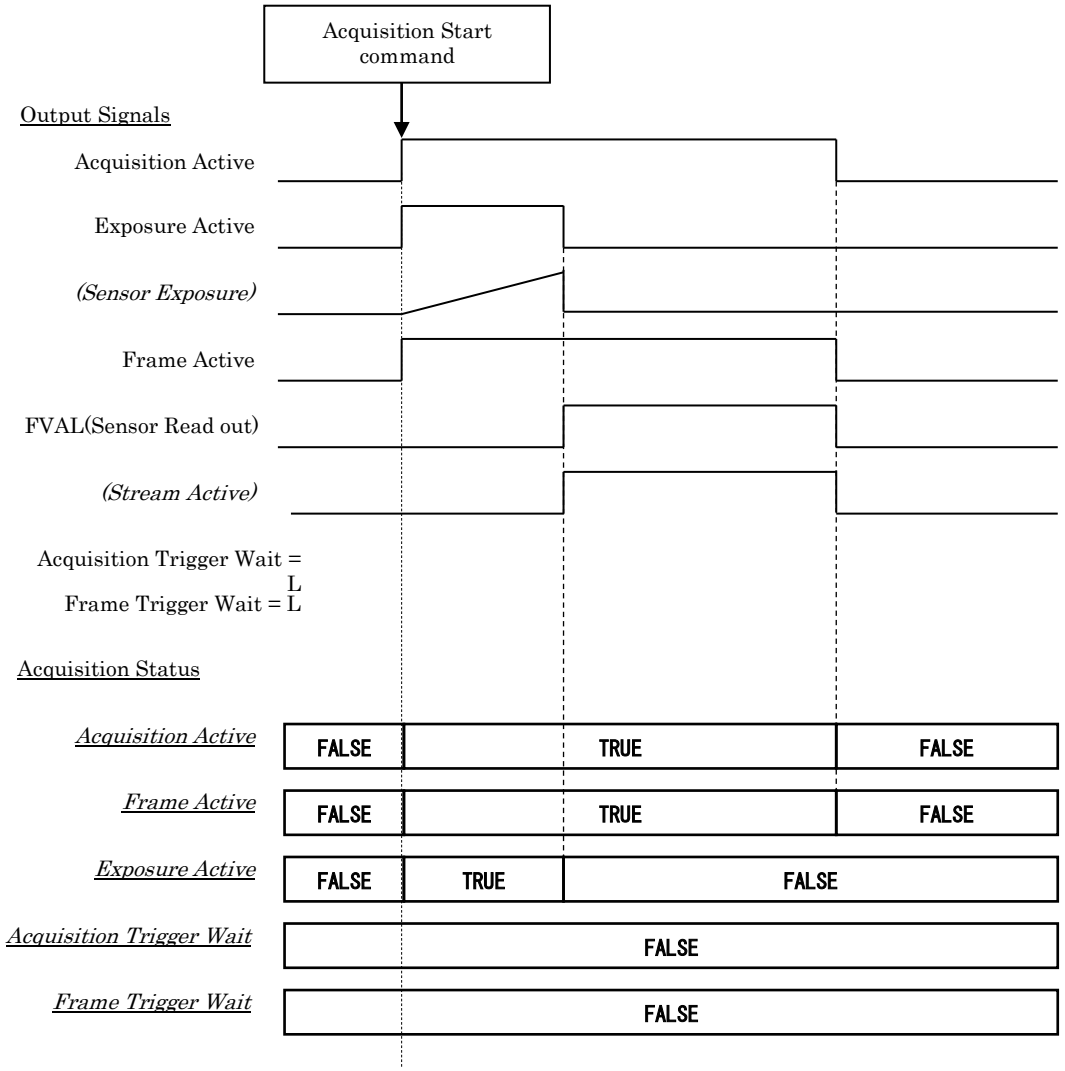
In single frame mode, executing the AcquisitionStart command causes one frame to be captured. After one frame is captured, this operation is automatically stopped.
In order to restart the capture, it is necessary to input the AcquisitionStart command again. BlockID is not reset until AcquisitionStop is input and is incremented when the AcquisitionStart command is called.
In the case of PIV operation, 2 frames are captured.

◆ Normal single frame operation
1) AcquisitionStart command is input
2) AcquisitionActive becomes “TRUE” (accepts capture)
3) 1 frame is output
4) AcquisitionActive becomes “FALSE” (stop capturing)

◆ Forcing acquisition to stop
While AcquisitionActive is “TRUE”, if AcquisitionStop or AcquisitionAbort is initiated, AcquisitionActive becomes “FALSE” (stop capturing).
However, if AcqusitionStop command is initiated during image output period, AcqusitionActive becomes “FALSE” (stop capturing) after image output is completed.

Associated commands : Acqusition Start, Acqusition Stop

Setting condition 1
Acquisition Mode： Single
Trigger Selector： Acquisition Start
Trigger Mode： OFF



Note: On the above timing chart, signals indicated by ( ) describe operation inside the camera.

Fig.24 Single Frame operation timing（1）

Setting condition 2
Acquisition Mode : Single
Trigger Selector : Acquisition Start
Trigger Mode : ON

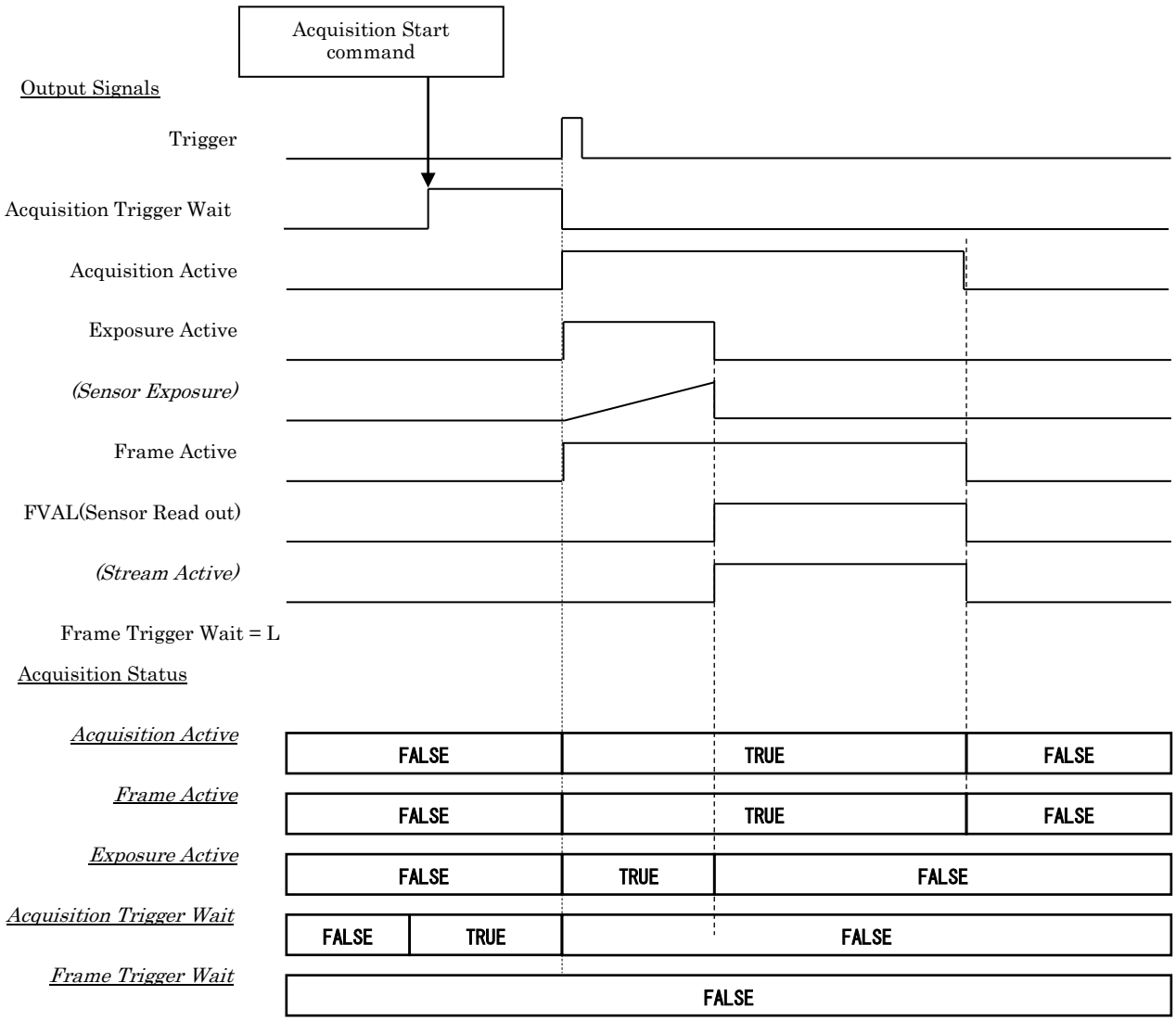


Fig.25 Single Frame operation timing (2)

Setting condition 3

Acquisition Mode : Single
Trigger Selector : Frame Start
Trigger Mode : ON

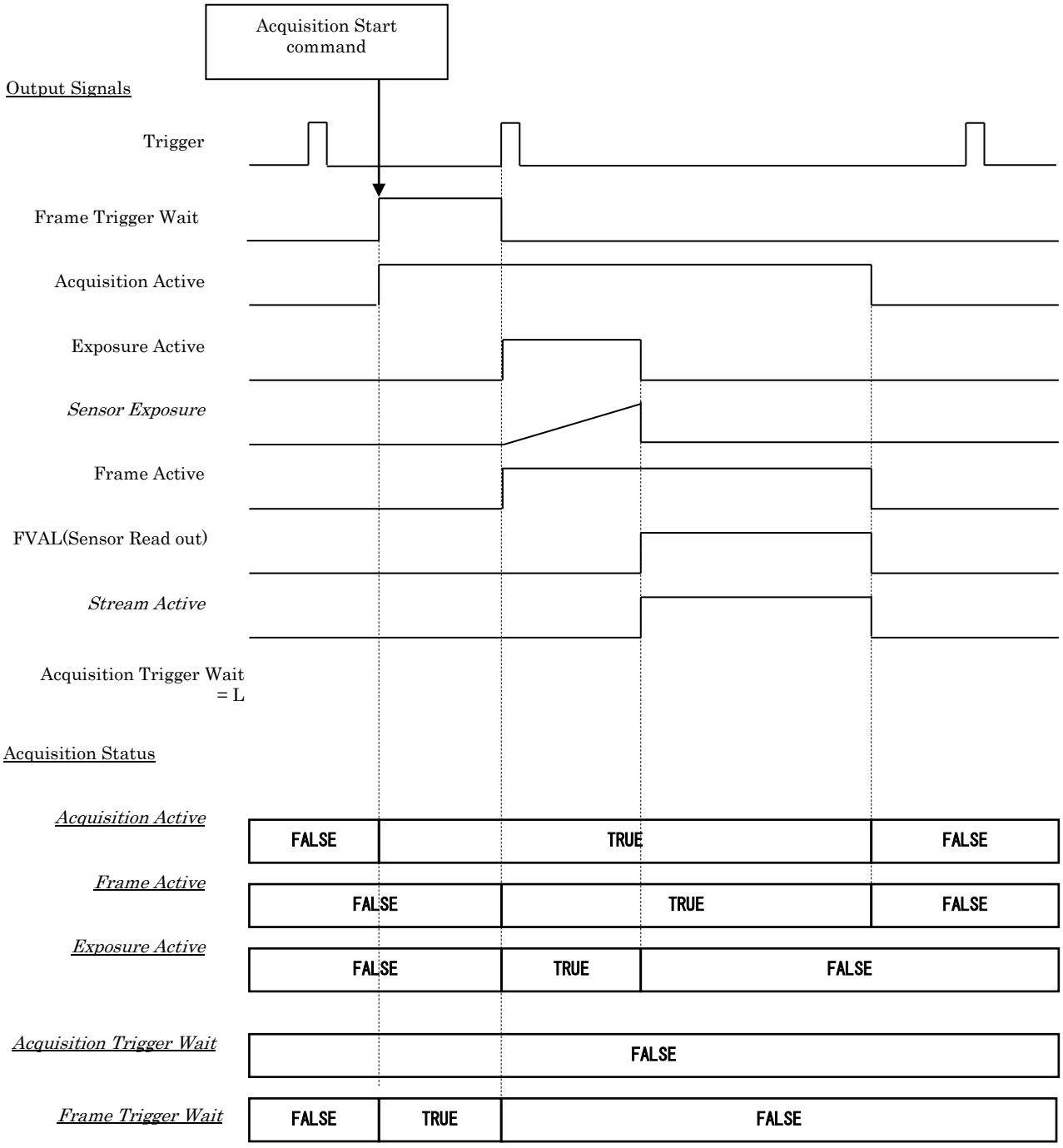


Fig.26 Single Frame operation timing (3)

7.1.1.2 Multi Frame operation

In this mode, the AcquisitionStart command captures the number of frames which are specified by AcquisitionFrameCount.

◆ Normal multi-frame operation
1) AcquisitionStart command is input
2) AcquisitionTriggerWait becomes effective
3) AcquisitionActive becomes "TRUE" (accepts capture)
4) Output N frames as specified by AcquisitionFrameCount
5) AcquisitionActive becomes "FALSE". Then the output stops. (See the following diagram)

◆ Forcing acquisition to stop
While AcquisitionActive is "TRUE", if AcquisitionStop or AcquisitionAbort is initiated, AcquisitionActive becomes "FALSE" (stop capturing).
Once the operation is set to "FALSE", the internal FrameCount is reset.
However, if AcqusitionStop command is initiated during image output period, AcqusitionActive becomes "FALSE" (stop capturing) after image output is completed.
Once, AcqusitionActive becomes "FALSE", the internal count is reset.

◆ Acqusition Frame Count (16-bit): Can be set in the range of 1 to 65535
In PIV mode, Acquisition Frame Count (16-bit) can be set in the range of 2 to 65535.
The setting for PIV mode is 2 steps.

Associated commands: Acqusition Start, Acqusition Frame Count, Acquisition Stop

Setting condition 1

Acquisition Mode： Multi
Trigger Selector： Acquisition Start
Acquisition Frame Count： 2
Trigger Mode： OFF

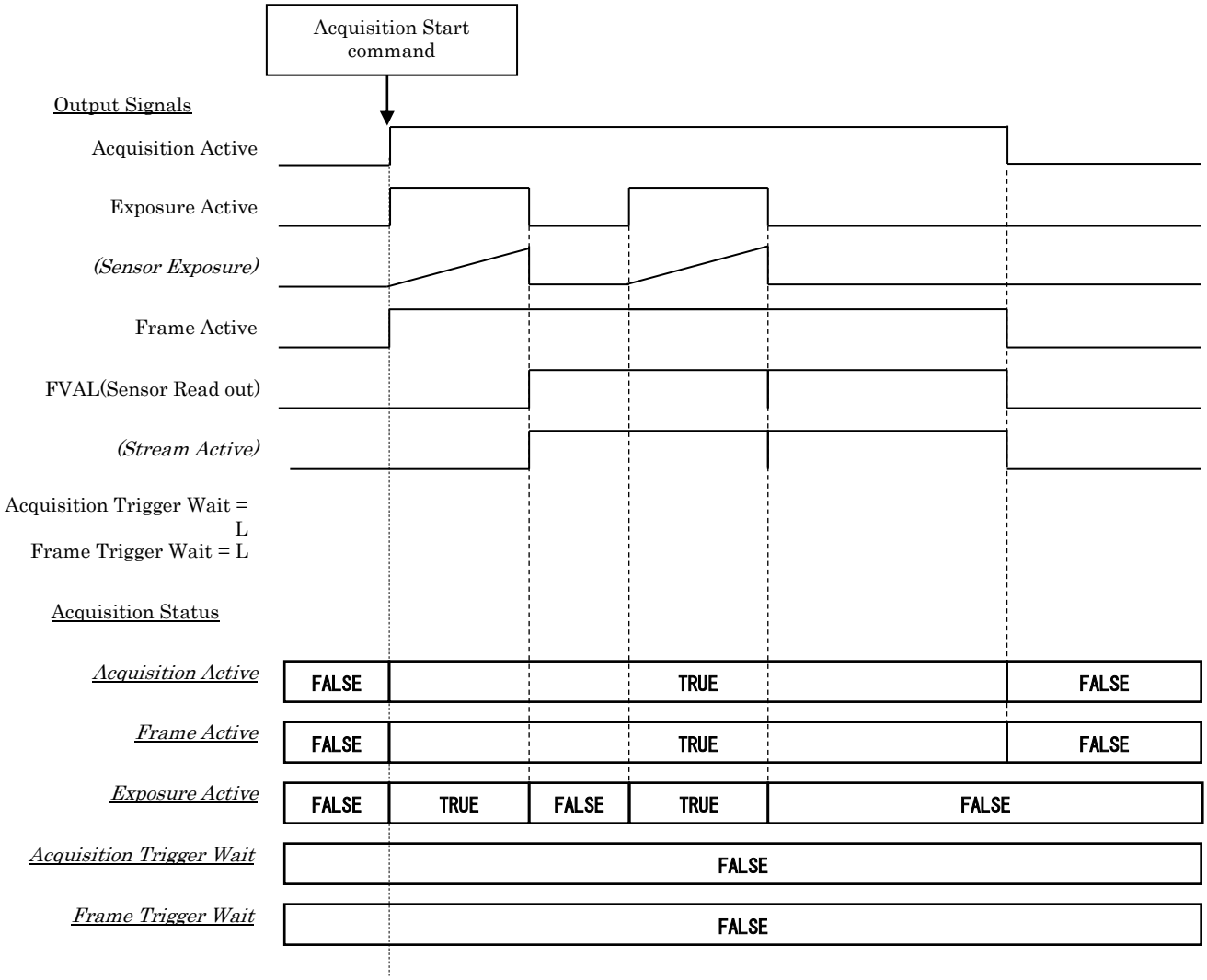


Fig.27 Multi Frame operation timing (1)

Setting operation 2
Acquisition Mode： Multi
Trigger Selector： Acquisition Start
Acquisition Frame Count： 2
Trigger Mode： ON

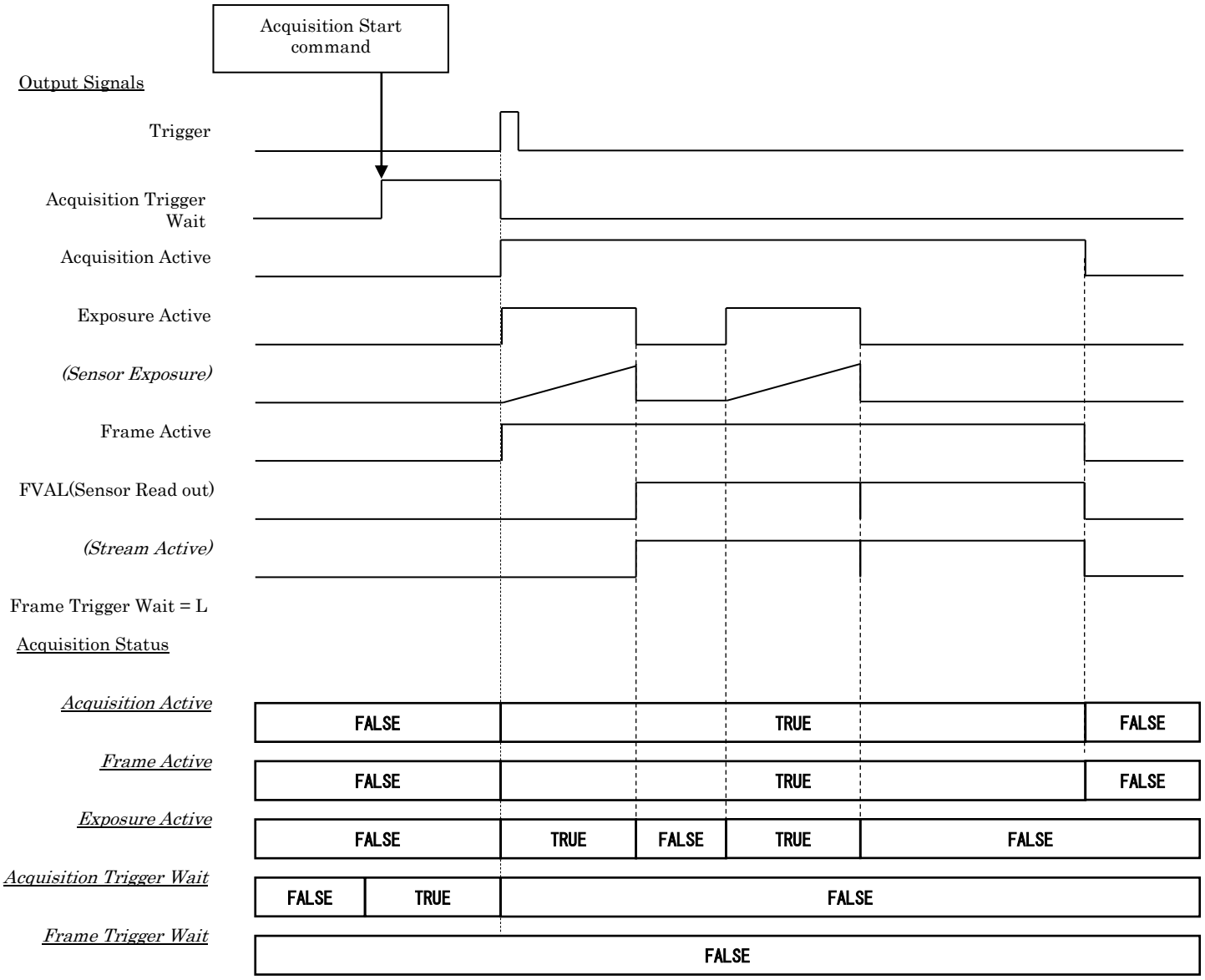


Fig.28 Multi Frame operation timing (2)

Setting operation 3

Acquisition Mode： Multi
Trigger Selector： Frame Start
Acquisition Frame Count： 2
Trigger Mode： ON

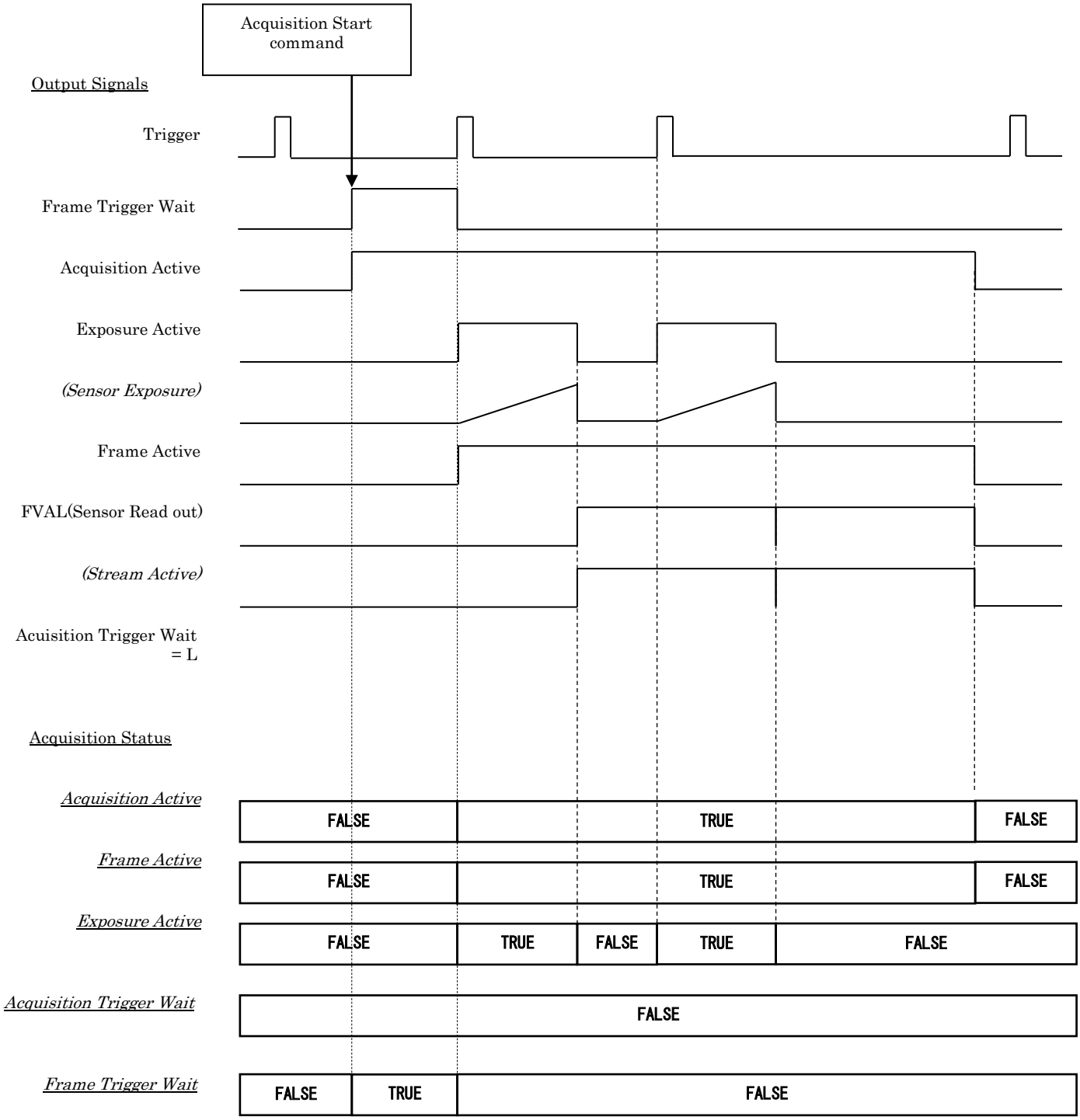


Fig.29 Multi Frame operation timing (3)

7.1.1.3 Continuous

In this mode, when the AcquisitionStart command is set, the image is continuously output at the current frame rate. This is the default setting for the SP-5000M-GE2 and SP-5000C-GE2.

1) AcquisitionStart command is input
2) AcquisitionTriggerWait becomes effective
3) AcquisitionActive becomes "TRUE"
4) Images begin outputting continuously
5) AcquisitionStop command is sent
6) AcquisitionActive becomes "FALSE". At this moment, the output stops.

However, if AcqusitionStop command is initiated during image output period, AcqusitionActive becomes "FALSE" (stop capturing) after image output is completed.

Associated commands : Acqusition Start, Acqusition Stop

Setting operation 1

Acquisition Mode : Continuous
Trigger Selector : Acquisition Start
Trigger Mode : OFF

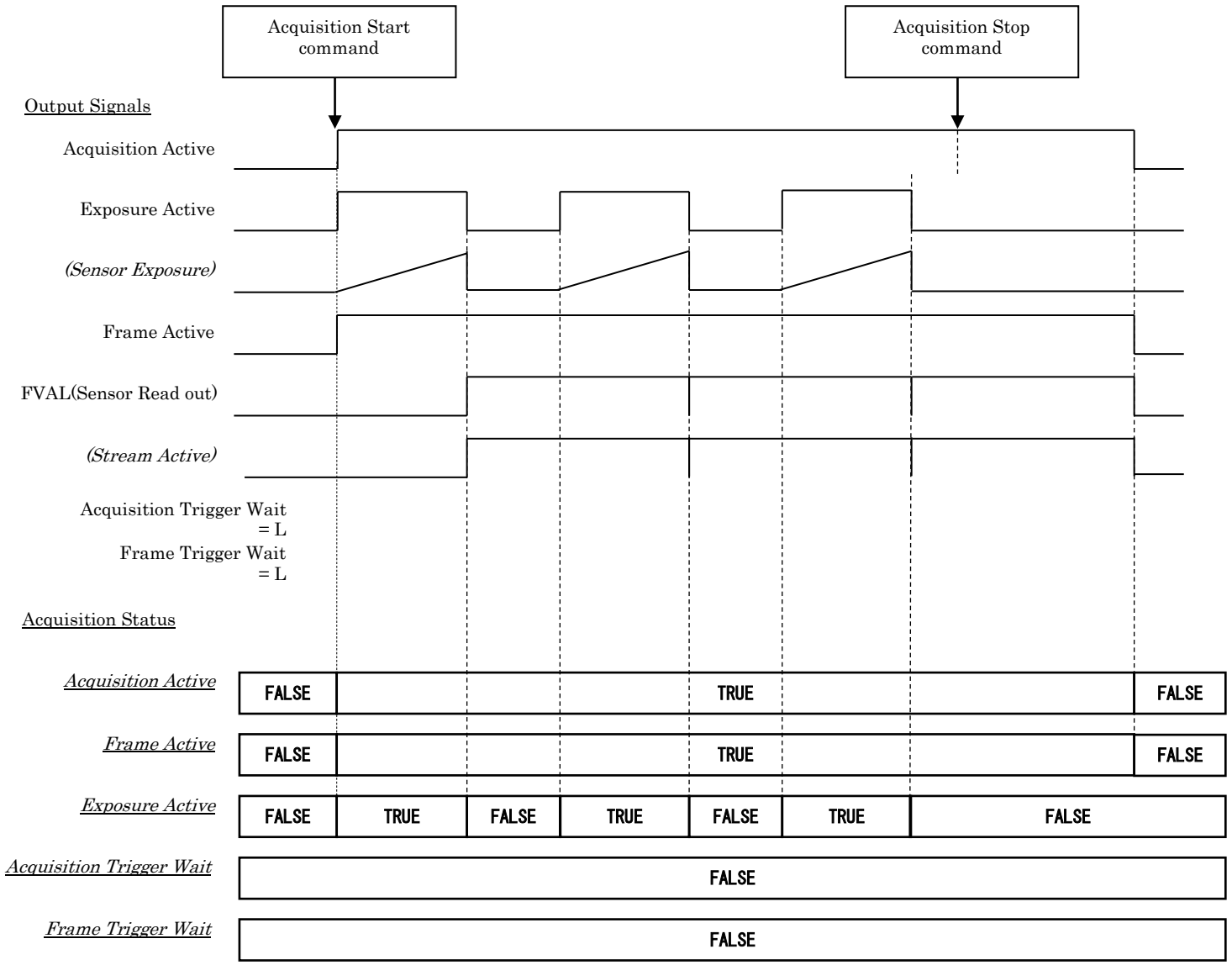


Fig.30 Continuous operation timing (1)

Setting condition 2
Acquisition Mode : Continuous
Trigger Selector : Acquisition Start
Trigger Mode : ON

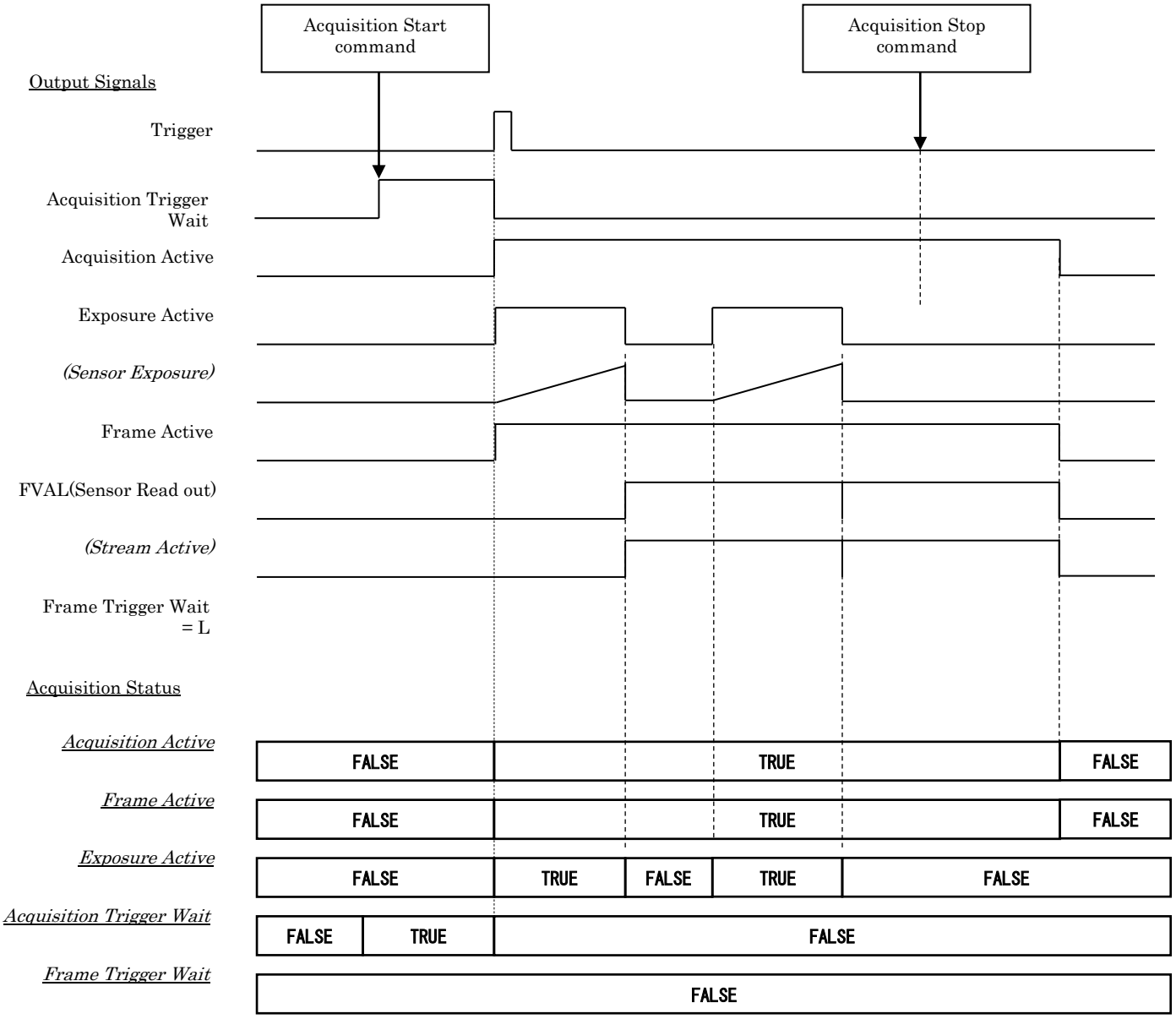


Fig.31 Continuous operation timing (2)

Setting condition 3

Acquisition Mode : Continuous
Trigger Selector : Frame Start
Trigger Mode : ON

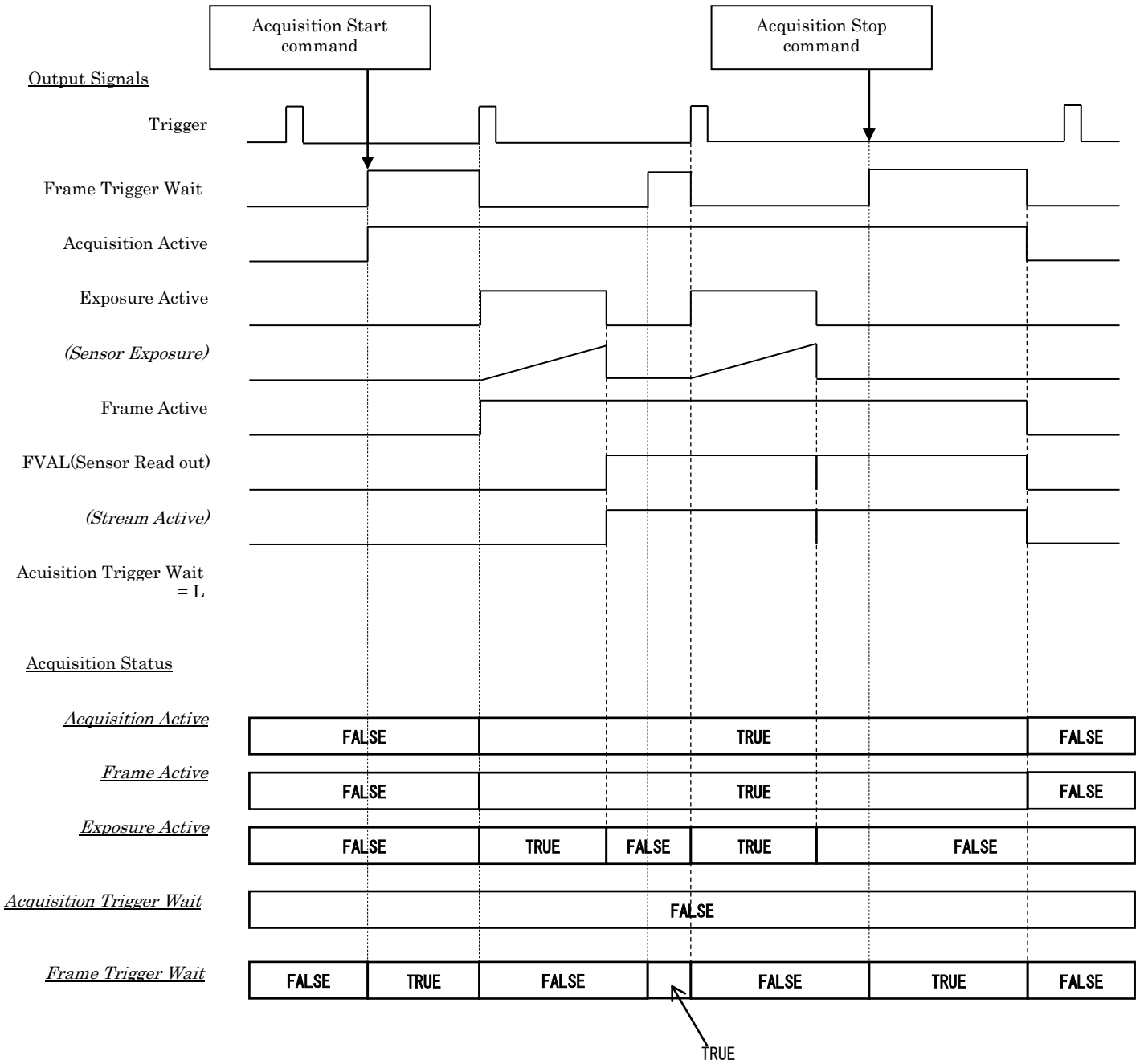


Fig.32 Continuous operation timing (3)

7.1.2 Acquisition frame rate

With Trigger OFF (free running mode – see section 7.2.1), the default frame rate of the camera is based on the specified ROI. The smaller the ROI, the faster the default frame rate. However, it is possible to specify a free-running frame rate (i.e., no trigger needed) that is slower than the default rate. This can be useful when a longer exposure time is needed for a specific ROI.

Modification of the frame rate is done by entering a value in the AcquisitionFrameRate control corresponding to the frame frequency. Allowed values range from 6999 Hz to 0.125 Hz (μs) for SP-5000-GE2, however if the value entered is less than the time required for the default frame rate, the setting is ignored and the default frame rate is used. For example, the minimum frame period for the smallest possible ROI (8 lines) requires 6999 Hz (fps)(8-bit, LAG), so any entry more than 6999 Hz (fps) will always be ignored.

The setting range in Acquisition Frame Rate is:

Shortest	to	Longest
Inverse number of time required to drive all pixels in the area set by ROI command or inverse number of time required to transmit one frame data	to	0.125 Hz (fps) = 8 seconds

For the above setting, Acquisition Frame Rate is used and its unit is Hz (fps).
Acquisition Frame Rate: 6999 Hz (fps) to 0.125 Hz (fps)

7.1.3 Calculation of frame rate

The actual frame rate is the smaller one between the sensor output frame rate and frame rate of network bandwidth. If frame rate of network bandwidth is smaller than sensor output frame rate, sensor output frame rate is automatically adjusted to match frame rate of network bandwidth.
The calculation formula for each frame rate is the following.

7.1.3.1 Calculation of sensor output maximum frame rate

Parameters

Clock of line	
400	Mono8, Bayer8
770	Mono10, Mono10Packed,Bayer10, Bayer10Packed, YUV411Packed, YUV422Packed
1500	RGB8, YUV444Packed
Additional clock	
32	Mono10Packed, Bayer10Packed, YUV411Packed
0	Other formats
Horizontal binning	
1	OFF
2	ON

Clock number of 1 line
ValidClocksOfLine = (ClocksOfLine - AddtionalClocks) x (Width + 127) / 128 x 128 / 2560 + 1 + AddtionalClocks
If the result is less than 165, ValidClocksOfLine = 165;
Clock number of 1 frame
ClocksOfFrame = (ValidClocksOfLine + (BinningHorizontal - 1) x 4) x (Height + 7) + 858

The maximum frame that sensor can operate
SensorFrameRate (Hz) = 48000000 / ClocksOfFrame

7.1.3.2 Calculation of frame rate of network bandwidth

Parameters

Network bit rate	
1000000000	Single link
2000000000	LAG(sLAG, dLAG)

Bit per pixel	
8	Mono8, Bayer8
12	Mono10Packed, Bayer10Packed, YUV411Packed
16	Mono10, Bayer10, YUV422Packed
24	RGB8, YUV444Packed

Packet_Size:
Value set in Packet Size register (GevSCPSPacketSize)

Byte number of 1 frame image
ImageSize = Width * Height x BitsPerPixel / 8

Image byte number of last packet
SizeOfLastPacket = The reminder of the calculation [ImageSize mod (PacketSize - 36)]

Ethernet Frame Size of 1 frame image
If SizeOfLastPacket is 0,
FrameSize = [ImageSize / (PacketSize - 36)] x (PacketSize + 28) + 146

If SizeOfLastPacket is not 0,
FrameSize = [ImageSize / (PacketSize - 36)] x (PacketSize + 28) + 210 + SizeOfLastPacket

The maximum frame rate which can be transferred through network
NetworkFrameRate (Hz) = Network_Bit_Rate x 0.11625 / FrameSize

Note: 0.11625 is coefficient which limits the bandwidth at 93%.

7.2. Exposure settings

This section describes how to set the exposure settings.

7.2.1 Exposure Mode

The exposure mode can be selected from the following three ways.

Table18. Exposure mode

Exposure Mode setting	Exposure operation
OFF	No exposure control (free-running operation)
Timed	Exposure operation at the value set in Exposure Time. Setting value is usec unit. ・If Trigger Mode setting is OFF, the camera is in free-running operation. ・If Trigger Mode setting is ON, the exposure operation depends on the setting of Trigger Option.
Trigger Width	The exposure is controlled by the pulse width of the external trigger. ・Trigger Mode is forced to ON.

For trigger operation, Exposure Mode must be set to something other than OFF and Trigger Mode of Frame Start must be ON.
If Exposure Mode is set at Timed, the exposure operation can be selected as follows by setting Trigger Option

Table19. Trigger option

Trigger Option setting	Exposure operation
OFF	Timed (EPS) mode
RCT	RCT mode
PIV	PIV (Particle Image Velocimetry) mode

The effect of the combination of Exposure Mode, Trigger Option and Trigger Mode is as follows.

Table20. The combination of Exposure Mode, Trigger Option and Trigger Mode

Exposure Mode	Trigger Option	Trigger Mode (Frame Start)	Operation
OFF	N/A	N/A	Self-running operation Exposure control by Exposure Time is not possible
Timed	OFF	OFF	Self-running operation Exposure control by Exposure Time is not possible
		ON	Timed (EPS) Operation Exposure can be controlled by Exposure Time
	RCT	Forced to ON	RCT Operation Exposure can be controlled by Exposure Time
	PIV	Forced to ON	PIV Operation Exposure can be controlled by Exposure Time
Trigger Width	N/A	Forced to ON	Exposure is controlled by the pulse width of the external trigger

7.2.2 Exposure Time

This command is effective only when Exposure Mode is set to Timed. It is for setting exposure time. The setting step for exposure time is 1 μsec per step.

Minimum: 10 μsec
Maximum: 8 seconds (Note – noise may make image unusuable after 2 seconds)

7.2.3 Exposure Auto

This is a function to control the exposure automatically. It is effective only for Timed.
JAI ALC Reference controls the brightness.

There are three modes, OFF, Once and Continuous.
OFF: No exposure control
Once: Exposure adjusts when the function is set, then remains at that setting
Continuous: Exposure continues to be adjusted automatically

In this mode, the following settings are available.
ALC Speed: Rate of adjustment can be set
ASC Max: The maximum value for the exposure time to be controlled can be set
ASC Min: The minimum value for the exposure time to be controlled can be set
ALC Reference: The reference level of the exposure control can be set
ALC Area Type : The area for exposure control can be set (common with Gain Auto)
ALC Customer Area Selector: Select the exposure area from 16 choices (4x4)
ALC Area Enable: This can Enable or Disable the area selected by ALC Custom Area Selector

Fig.33 ALC Area Type

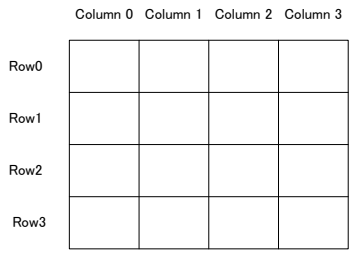


Fig.32 ALC Custom Area selector

7.3. Trigger Control

The following 6 types of Trigger Control are available by the combination of Trigger Selector, Trigger Mode, Exposure Mode and Trigger Option.

Table21. Trigger control

Camera Settings				JAI Custom Trigger Mode Name	Description
Trigger Selector	Trigger Mode	Exposure Mode	Trigger Option		
Frame Start	Off	Off	Off	Continuous Trigger	Free running operation with the maximum exposure time per the frame rate
	Off	Timed	Off	Continuous Trigger	Free running operation with a user-set exposure time.
	On	Timed	Off	EPS Trigger	Externally triggered operation with a user-set exposure time
	On	Timed	RCT	RCT Trigger	Externally triggered operation for RCT
	On	Timed	PIV	PIV Trigger	Externally triggered operation for PIV
	On	Trigger Width	Off	PWC Trigger	Externally triggered operation with a pulse width exposure time

7.3.1 Trigger Selector

Selects the trigger operation. In the SP-5000-GE2, the following trigger operation can be selected as the trigger.

Table22. Trigger selector

Trigger Selector Item	Description
Frame Start	Frame Start Trigger operation
Acquisition Start	Acquisition Start Trigger operation
Acquisition End	Acquisition End Trigger operation

7.3.2 Trigger Mode

Select either free-running operation or external trigger operation.

OFF: Free-running operation
ON: External trigger operation

7.3.3 Trigger Source

The following signals can be used as the trigger source signal.

Table23. Trigger source

Trigger Source item	Description
Low	Connect LOW level signal to the selected trigger operation **Default setting**
High	Connect HIGH level signal to the selected trigger operation
Soft Trigger	Connect Soft Trigger signal to the selected trigger operation Trigger can be input manually by the execution of the software trigger Trigger software is available on each trigger source.
PulseGenerator0 Out	Connect Pulse generator 0 signal to the selected trigger operation
PulseGenerator1 Out	Connect Pulse generator 1 signal to the selected trigger operation
PulseGenerator2 Out	Connect Pulse generator 2 signal to the selected trigger operation
PulseGenerator3 Out	Connect Pulse generator 3 signal to the selected trigger operation
Line 5 - OPT IN 1	Connect TTL 1 IN signal to the selected trigger operation
Line 6 - OPT IN 2	Connect OPTO IN 1 signal to the selected trigger operation
NAND 0 Out	Connect NAND 0 OUT signal to the selected trigger operation
NAND 1 Out	Connect NAND 1 OUT signal to the selected trigger operation
User Output 0	Connect User Output 0 signal to the selected trigger operation. 0 or 1 status can be sent by User 0 command from PC (Host side).
User Output 1	Connect User Output 1 signal to the selected trigger operation. 0 or 1 status can be sent by User 0 command from PC (Host side).
User Output 2	Connect User Output 2 signal to the selected trigger operation. 0 or 1 status can be sent by User 0 command from PC (Host side).
User Output 3	Connect User Output 3 signal to the selected trigger operation. 0 or 1 status can be sent by User 0 command from PC (Host side).
Action1	Connect Action 1 signal to the selected trigger operation.
Action2	Connect Action 2 signal to the selected trigger operation.
Line 10 - TLL IN 2	Connect TTL 2 IN signal to Line 10
Line 11 - LVDS IN	Connect LVDS 1 IN signal to Line 11

7.3.4 Trigger activation

This command can select how to activate the trigger.

Rising Edge: At the rising edge of the pulse, the trigger is activated.
Falling Edge: At the falling edge of the pulse, the trigger is activated.

Note: When Trigger Width mode is used, the trigger is initiated at the rising edge or falling edge and the exposure time is the duration at the falling edge or rising edge of the trigger input pulse.

7.3.5 Trigger Overlap

This function defines whether or not a trigger pulse can be accepted while data is being read out.

OFF : The trigger pulse is not accepted during the sensor readout.
Read Out : The trigger pulse can be accepted during the sensor readout.

7.4. Normal continuous operation (Timed Exposure Mode/Trigger Mode OFF)

This is used for applications which do not require triggering. In this mode, the video signal for the auto-iris lens is available if AUX connector is configured with option Type 2.
For the video timing, refer to chapter 6.3.

Primary settings to use this mode

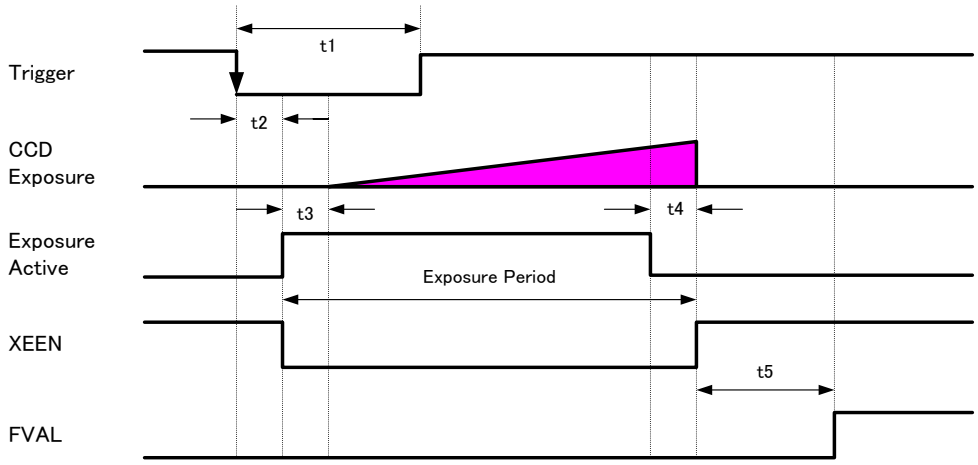
Trigger Mode: Off

7.5. Timed mode

This mode allows a single image frame to be captured with a preset exposure time by using the external trigger. Additional settings determine if the trigger pulse can be accepted during the exposure period.

Primary settings to use this mode
Exposure Mode: Timed
Trigger Mode: ON
Trigger Option: OFF

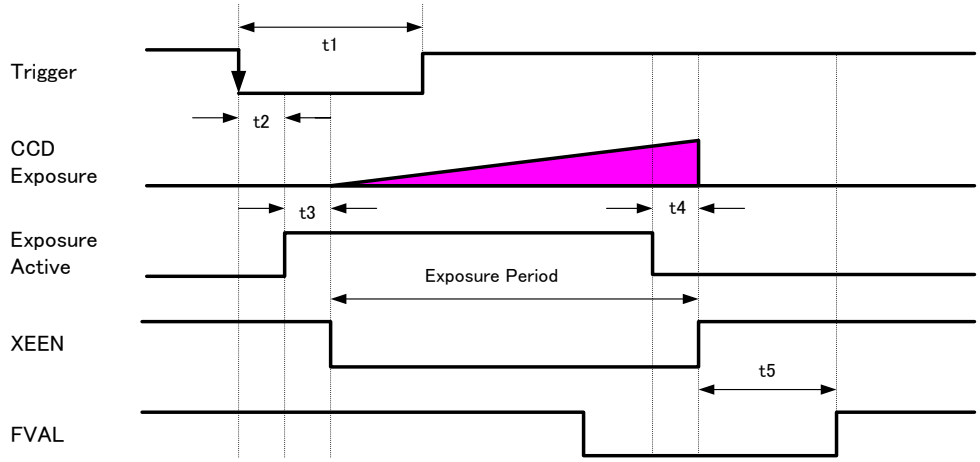
7.5.1 If the overlap setting is "OFF"



t1	t2	t3	t4	t5
2L (Min)	30 μs	10.13 μs	2.51 μs	8L to 9L (18.142 μs)

Fig.34 Overlap OFF

7.5.2 If the overlap setting is “Readout”



t1	t2	t3	t4	t5
2L	30 μs	10.13 μs	2.51 μs	8L to 9L (18.142 μs)

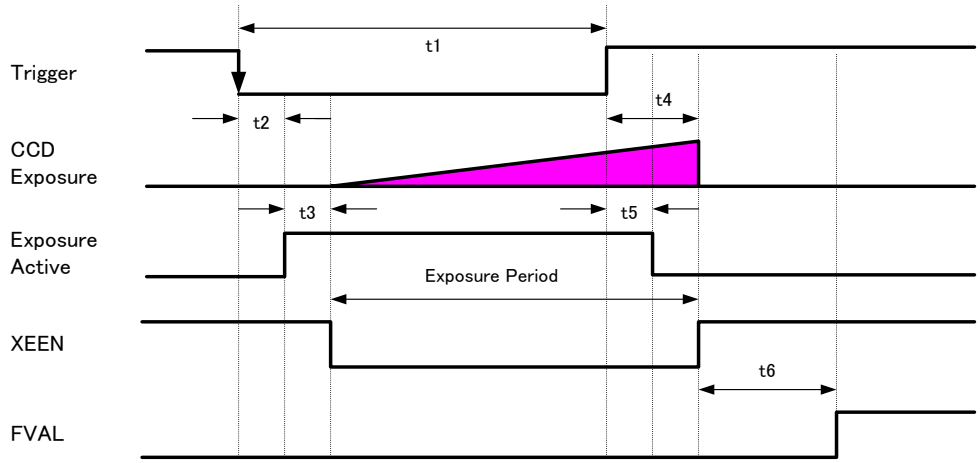
Fig.35 Readout

7.6. Trigger width mode

In this mode, the exposure time is equal to the trigger pulse width. Accordingly, longer exposure times are supported. Additional settings determine if the trigger pulse can be accepted during the exposure period.
The frame rate of full pixels readout is 44 fps.

Primary settings to use this mode
Exposure Mode: Trigger Width
Trigger Mode: ON
Trigger Option: OFF

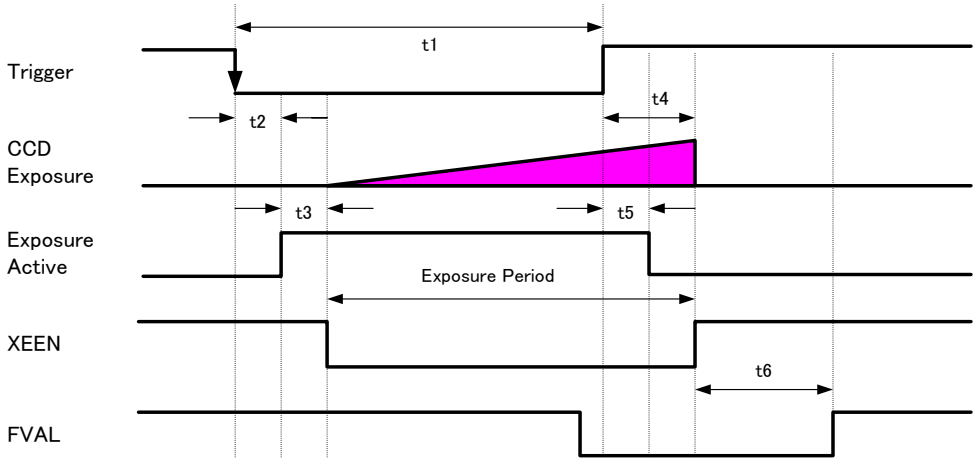
7.6.1 If the overlap setting is “OFF”



t1	t2	t3	t4	t5	t6
2L (Min)	30 μs	10.158 μs	2.75 μs	226 ns	7L to 8L

Fig.36 Overlap = OFF

7.6.2 If the overlap setting is “Readout”

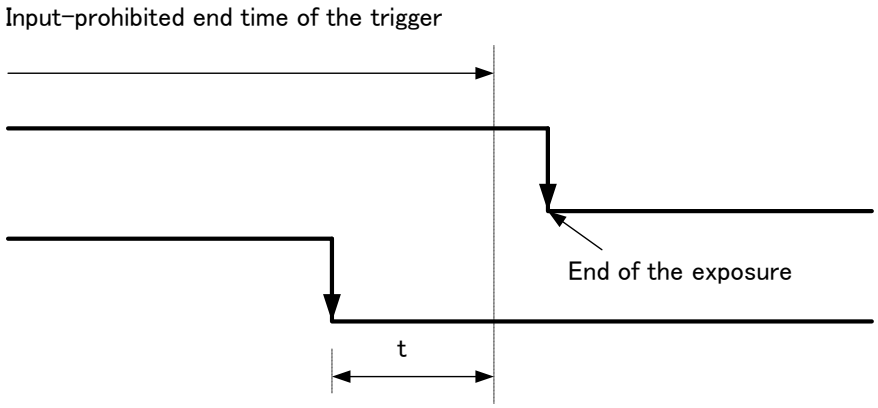


t1	t2	t3	t4	t5	t6
2L(min)	30 μs	10.158 μs	2.75 μs	226 ns	7L to 8L

Fig.37 Readout

Note: Timing at the end of the trigger if the trigger overlap is set to READOUT

As for the timing for the end of the exposure by the external trigger pulse, its input-prohibited end time from the previous frame varies based on the pixel format used.



t	
8-bit	5.5 ms
10-bit Unpacked	12.34 ms
10-bit Packed	0.952 ms

If the trigger overlap is set to READOUT, the period from FVAL end to Input-prohibited end time of the trigger varies depending on the pixel format used.

Fig. 38 Trigger end time

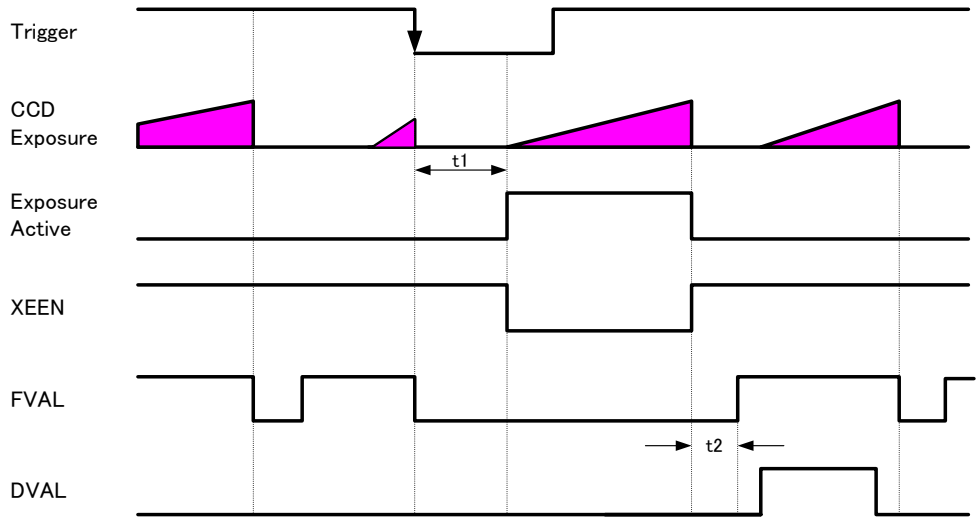
7.7. RCT mode

Until the trigger is input, the camera operates continuously and the video signal for the auto-iris lens is output, provided the AUX connector has been ordered with a Type 2 configuration option. At this moment, the video signal, FVAL and LVAL are output but DVAL is not output. When the trigger is input, the fast dump is activated to read out the electronic charge very quickly, after which the accumulation and the readout are performed. When the accumulated signal against the trigger is read out, FVAL, LVAL and DVAL are output too.

Primary settings to use this mode

Exposure Mode: Timed
Trigger Mode: ON
Trigger Option: RCT

In this mode, the setting of Trigger Overlap is invalid.



t1	t2
100μs	8L ～9L

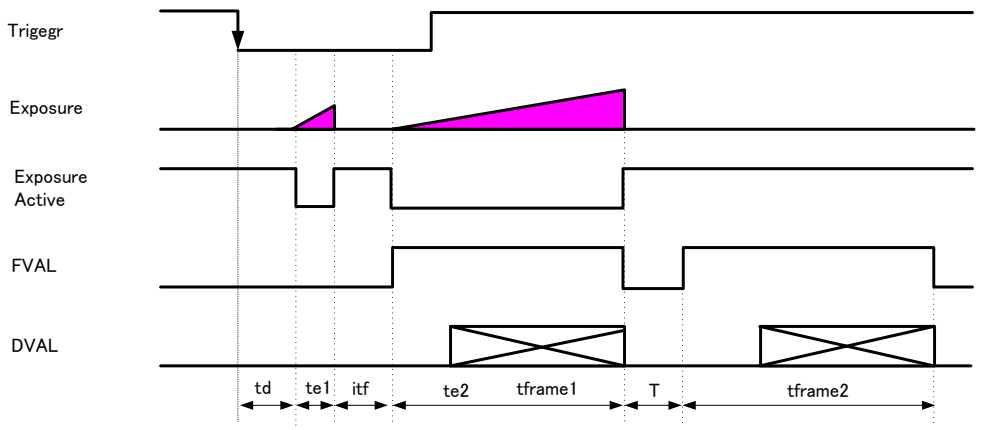
Fig.39 RCT mode timing

7.8. PIV (Particle Image Velocimetry)

The Particle Image Velocimetry mode can be used in applications where 2 images need to be taken with a very short time interval. It can only be used with strobe flash as illumination. The first accumulation time is 10 μsec to 2 sec. Then, the second exposure will be taken. The accumulation is LVAL asynchronous. The first strobe is activated during the first exposure duration and the second strobe is pulsed while the first frame is being read out. In this way, two strobe flashes generate two video outputs.

Primary Settings
Exposure Mode: Timed
Trigger Mode: ON
Trigger Option: PIV

In this mode, the setting of Trigger Overlap is invalid.



time name	description	time
td	Exposure beginning delay	755clk
te1	First exposure time period	10μs ～ 2s
te2	Second exposure time	2515 frames
itf	Inter framing time	3514clk
T	FVAL non active	10LVAL
tframe1	First Frame read out	1 frame
tframe2	Second Frame read out	1 frame

Fig.40 PIV mode

7.9. Sequence ROI Trigger

This mode allows the user to define a preset sequence of up to 10 images, each with its own ROI, exposure time and gain values.

Primary settings to use this mode

Exposure Mode: Timed
Trigger Mode: ON
Video Send Mode: Trigger Sequence or Command Sequence

7.9.1 Video send mode

The sequential trigger mode is selected via the Video Send Mode command and has the following options.

Table 24. Video send mode

Mode selected	Index selection method
Trigger Sequence	Select the index by using the Frame Start trigger signal. (The setting index can be determined by the Next Index setting.)
Command Sequence	Select the index number to assign directly by using the Command Sequence Index command.

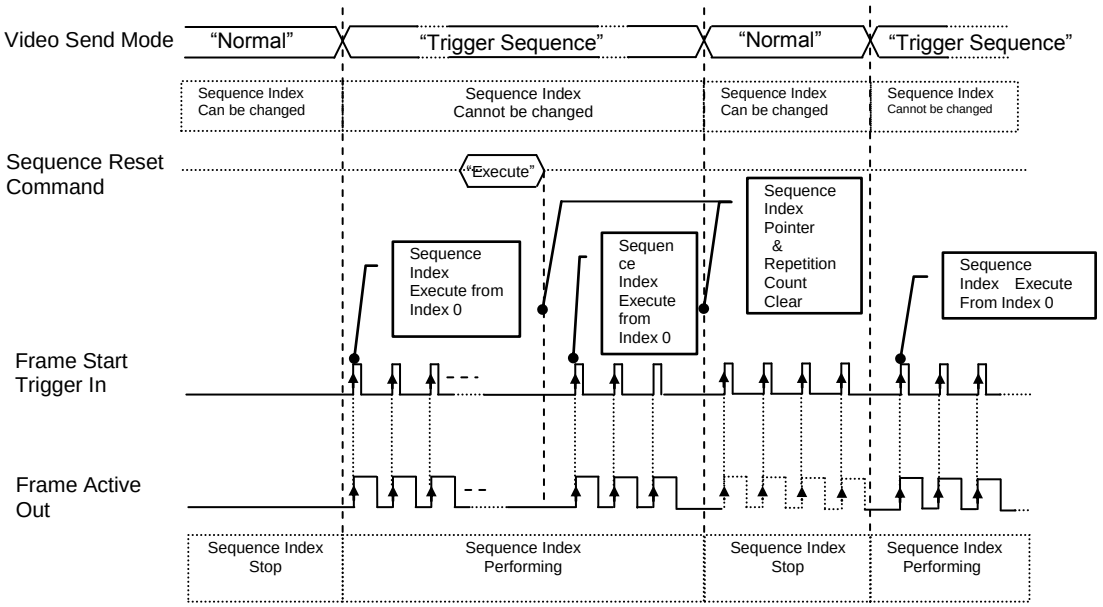


Fig. 41 Behavior if Video Send Mode is set to Trigger Sequence

7.9.2 Trigger Sequence mode basic timing

In this mode, as each trigger input is received, the image data associated with the next index within the preset sequence is output.

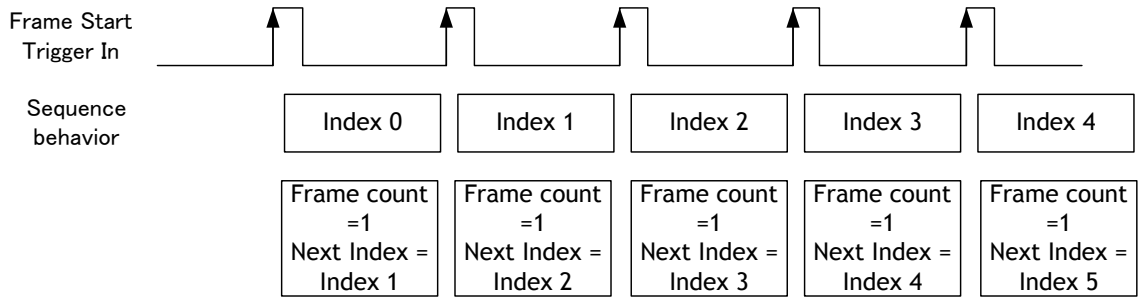


Fig. 42 Behavior of Sequence trigger

7.9.3 Sequence ROI setting parameters

7.9.3.1 Sequence index table (Default)

The following table shows the default settings.

Table25. Sequence Index table (Default)

Sequence ROI Index	Sequence ROI													
	Width	Height	Offset		Gain Selector			Exposure Time	Black Level	Binning		LUT Enable	Frame Count	Next Index
			X	Y	Gain (ALL)	Red	Blue			Horizontal	Vertical			
- Index 0	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 1	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 2	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 3	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 4	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 5	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 6	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 7	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 8	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0
- Index 9	2560	2048	0	0	100	0	0	180000	0	1 (Off)	1 (Off)	Off	1	Index 0

7.9.3.2 Descriptions of index table parameters

(1) Sequence ROI Index Selector
In Sequence ROI Index Selector, Index 0 to 9 can be selected.
Sequence ROI – Width, Height, Offset X, Offset Y, Gain Selector - Gain/Red/Blue, Exposure Time, Black Level, Binning Horizontal, Binning Vertical, LUT Enable, Frame Count, Next Index for the selected index are displayed.

(2) Sequence ROI Width
Set the width of sequence ROI. The setting range is 8 to 2560 pixels.
Rules for setting area and step number are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.

(3) Sequence ROI Height
Set the height of sequence ROI. The setting range is 8 to 2048 lines.
Rules for setting area and step number are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.

(4) Sequence ROI Offset X

Set Offset X of sequence ROI.
Sequence ROI Binning Horizontal = 1 (Off):
Setting range is 0 to (2544 - [Sequence ROI Width]) for Monochrome
Setting range is 0 to (2552 - [Sequence ROI Width]) for Color

Sequence ROI Binning Horizontal = 2 (On):
Setting range is 0 to (1272 - [Sequence ROI Width])
The limitations of step number and other factors are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.

(5) Sequence ROI Offset Y
Set Offset Y of sequence ROI.
Sequence ROI Binning Vertical = 1 (Off):
Setting range is 0 to (2046 - [Sequence ROI Height]) for both Monochrome and Color
Sequence ROI Binning Vertical = 2 (On):
Setting range is 0 to (1023 - [Sequence ROI Height])
The limitations of step number and other factors are the same as the normal ROI mode set by [Video Send Mode] =“Normal”.

(6) Sequence ROI Gain Selector
In Sequence ROI Gain Selector, the gain settings for each index are available.
SP-5000C-GE2: Gain (ALL), Red and Blue can be set.
SP-5000M-GE2: Only Gain is displayed and can be set.

(7) Sequence ROI Black Level
Black Level setting is available for each index.

(8) Sequence ROI Exposure Time
Exposure Time setting is available for each index.

(9) Sequence ROI Binning Horizontal
ON or OFF of Horizontal Binning for each index can be set.

(10) Sequence ROI Binning Vertical
ON or OFF of Vertical Binning for each index can be set.

(11) Sequence ROI LUT Enable
Enable or disable of LUT function for each index 0 to 9 can be set.

(12) Sequence ROI Frame Count
This can set how many times the selected index is repeated. This is applied to each index. Triggers are input according to numbers set in Frame Count and index is repeated and moves to the next index. Therefore, the same number of triggers as Frame Count must be input.

(13) Sequence ROI Next Index
The number of the index that will follow the current index can be set.
If [Video Send Mode] is set to “Trigger Sequence” and the trigger pulse is input in EPS trigger, the sequence is executed from index 0.

(14) Sequence ROI Reset Command
This command resets the current index pointer and reverts to index 0 in the table. Frame Count is also re-initialized.

7.10 Multi ROI function

This function divides one frame image into a maximum of 5 images vertically and reads out all areas in one frame. In this function, the width and the height can be set individually as required. Each ROI can also be overlapped. Refer to Fig. 43. The multi ROI function is enabled if [Video Sending Mode] is set to "Multi ROI".

Table26. Multi ROI Index table default values

Multi ROI Index Max	1			
Multi ROI Index Selector	Multi ROI			
	Width		Height	
	Width	Offset X	Height	Offset Y
- Index 0	8	0	8	0
- Index 1	8	0	8	0
- Index 2	8	0	8	0
- Index 3	8	0	8	0
- Index 4	8	0	8	0

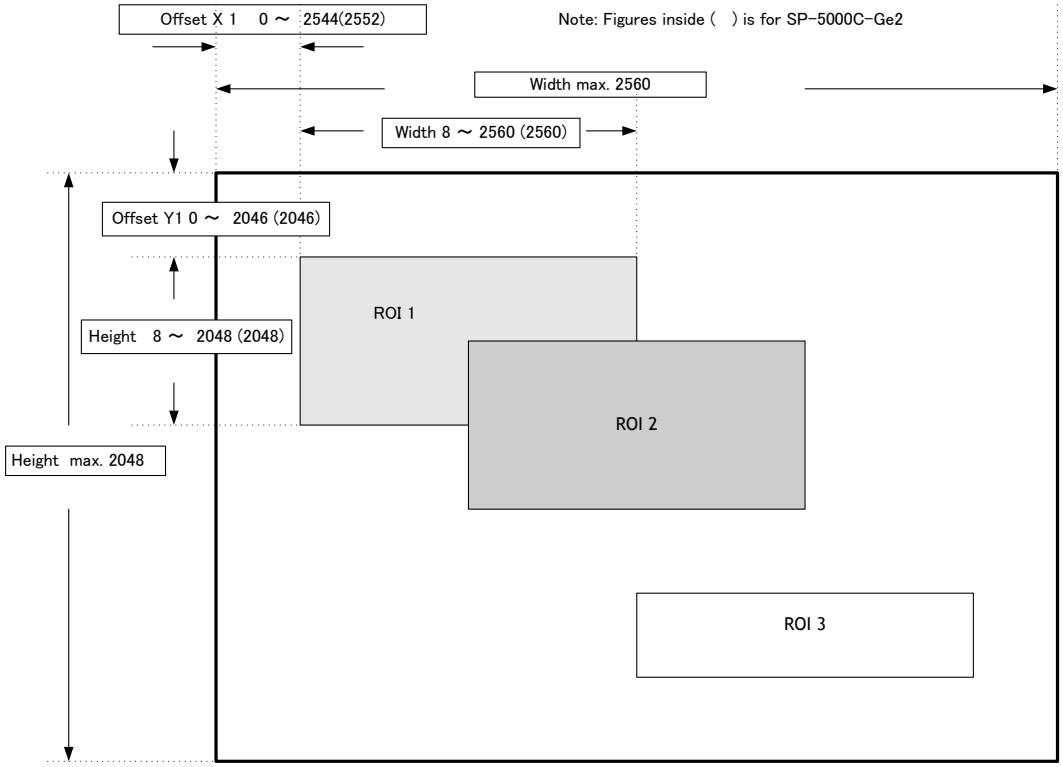


Fig.43 Multi ROI setting example

7.10.1 Multi ROI setting parameters

(1) Multi ROI Index Max : Setting value = 0 ～ 4

Maximum 5 ROI settings are possible in a frame. Set Index 0 through 4 in Multi ROI Index table as an application requires.

(2) Multi ROI Width

Multi ROI Width can be set individually for Multi ROI Index 0 to 4. The setting range and Step number are the same as the normal ROI setting in which "Video Send Mode" is set to "Normal". The restriction for setting Step and other factors are the same as the normal ROI setting.

(3) Multi ROI Index Selector :

Index 0 to 4 can be selected. [Height], [Offset X], and [Offset Y] of the selected Multi ROI Index are displayed and can be set.

(4) Multi ROI Offset X :

Offset X can be set for each ROI area of Multi ROI Index 0 to 4.
The restriction for setting Step and other factors are the same as the normal ROI setting.
The sum of Offset X and ROI Width must not be greater than Width Max.

(5) Multi ROI Height :

Height can be set for each ROI area of Multi ROI Index 0 to 4.
The restriction for setting Step and other factors are the same as the normal ROI setting.

(6) Multi ROI Offset Y :

Offset Y can be set for each ROI area of Multi ROI Index 0 to 4.
The restriction for setting Step and other factors is the same as the normal ROI setting.
The sum of Offset Y and ROI Height must not be greater than Height Max.

7.11. Operation and function matrix

Table27. Operation and function matrix

Exposure Operation	Trigger mode	Trigger Option	V-Binning Note1	H-Binning Note1	Exposure Time	ROI	AWB Note2	Auto Iris Output	Auto Gain	Auto Exposure	Trigger Overlap	Video Send Mode		HDR Note1
												Multi ROI	Sequence ROI	
OFF	OFF	OFF	1	1	×	○	○	○	○	×	×	○	×	×
			2	2	×	○	○	○	○	×	×	○	×	×
Timed	OFF	OFF	1	1	○	○	×	○	○	○	×	○	×	○
			2	2	○	○	×	○	○	○	×	○	×	○
Timed (EPS)	ON	OFF	1	1	○	○	×	○ (Note3)	○	×	○	○	○	○ (Note4)
			2	2	○	○	×	○ (Note3)	○	×	○	○	○	○ (Note4)
Trigger Width	ON	OFF	1	1	×	○	×	○ (Note3)	○	×	○	○	×	×
			2	2	×	○	×	○ (Note3)	○	×	○	○	×	×
Timed (RCT)	ON	RCT	1	1	○	○	○	○	○	○	×	○	×	×
			2	2	×	×	○	×	×	×	×	×	×	×
Timed (PIV)	ON	PIV	1	1	×	○	×	×	×	×	×	○	×	×
			2	2	×	×	×	×	×	×	×	×	×	×

Note 1. Only SP-5000M-GE2
Note 2: Only SP-5000C-GE2
Note 3: If the trigger interval is long period, the iris may occur the hunting.
Note 4: Trigger Overlap is OFF

8. Other functions

8.1 Black level control

This function adjusts the setup level.
The adjusting level is -64 to +63LSB at 10-bit output.

8.1.1 Black Level Selector

The following factors can be set.

SP-5000M-GE2: DigitalAll
SP-5000C-GE2: DigitalAll/DigitalRed/ DigitalBlue

8.1.2 Black Level

The black level can be set in the following range.

SP-5000M-GE2: DigitalAll : -512～ +511
SP-5000C-GE2: DigitalAll : -512～ +511
DigitalRed/DigitalBlue : -512～ +511

8.2 Gain control

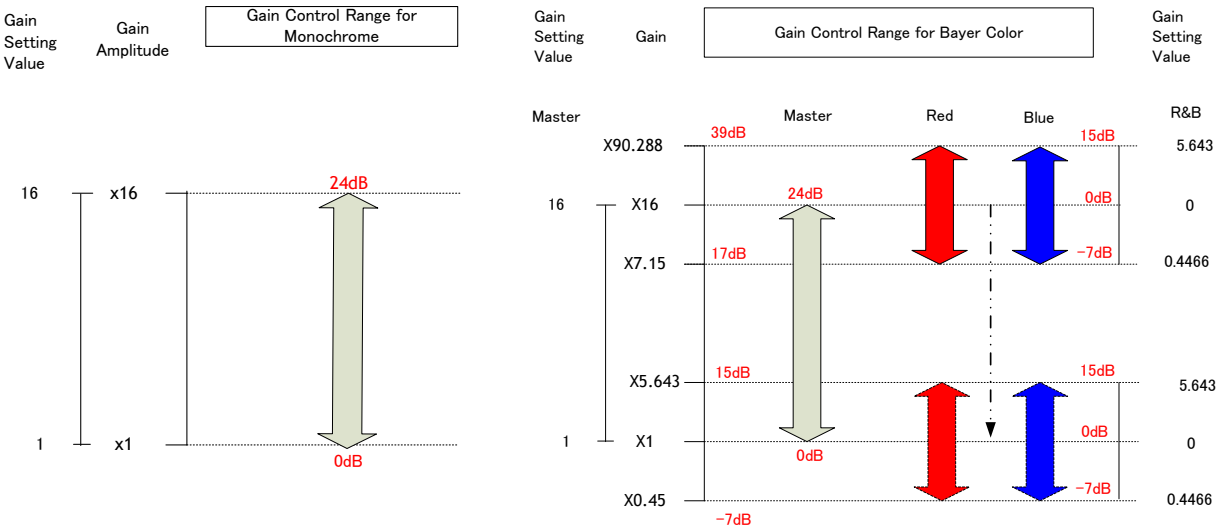
In the SP-5000-GE2, the gain control uses Analog Base Gain and Digital Gain.
Analog Base Gain can be set at 0dB, +6dB or +12dB for for both SP-5000M-GE2 and SP-5000C-GE2. In the SP-5000C-GE2, R, G and B channel can be adjusted individually or simultaneously.
The digital gain is used for the master gain setting.

For setting the gain,

1. Set analog gain (Select from 0dB, +6dB and +12dB)
2. Set digital gain
   The master gain (DigitalAll) for both monochrome and color can be set x1 (0dB) to x16 (+24dB) against the analog base gain. The resolution for gain setting is x0.01/step which is 0.05dB to 0.08dB, depending on the setting value.
3. In the SP-5000C-GE2, blue and red gain can be set from x0.45 to x5.62 against the master gain setting and its resolution is x0.01/step.
4. In the SP-5000C-GE2, analog gain can be applied to R, G and B channel respectively in order to cover wider range of color temperature.

Note1: If the gain up function is used, it is recommended to use the analog base gain as the master gain setting. For instance, if +12dB gain up is required, the analog base gain is set at +12dB and no digital gain is added. This is because the signal-to-noise is better on analog gain performance. However, the AGC function works only in digital gain.
Additionally, the analog base gain is effective in order to minimize the drop of the histogram at higher gain settings. Please note that the analog base gain has less accuracy due to its variability.

Note2: If Analog Base Gain is set at 0dB and Digital Gain is used at high gain setting, the video level may be unstable and fluctuating approx. 5%. In this case, it is suggested to set the analog base gain at +6dB or +12dB.



The master gain control uses Digital Gain Control. All digital gain can be set by x0.01/step. If the digital gain is set too high, a break in the Histogram may occur.

The above drawing shows the relation among gain setting value (command), gain amplitude, and dB indication. For example, the gain amplitude “x 5.643” equals 15dB.

Fig.44 Gain control

8.2.1 Gain Selector

The following parameters can be set.

SP-5000M-GE2: DigitalAll
SP-5000C-GE2: DigitalAll/Digital Red All/Digital Blue All

8.2.2 Gain

This is the reference value upon which gain adjustments are based. The operational adjustment is done in Gain Raw.

SP-5000M-GE2: DigitalAll : 1～16 (0dB to +24dB)
SP-5000C-GE2: DigitalAll : 1～16 (0dB to +24dB)
Digital Red All : 0.4466～5.643
Digital Blue All : 0.4466～5.643

8.2.4 Gain Auto

This function automatically controls the gain level.
This is controlled by the command JAI ALC Reference.

There are three modes.
OFF: Adjust manually.
Once: Operate only one time when this command is set
Continuous: Operate the auto gain continuously

The following detailed settings are also available.
ALC Speed: The rate of adjustment of GainAuto can be set (Common with ExposureAuto).

Gain Auto Max: The maximum value of GainAuto control range can be set
Gain Auto Min: The minimum value of GainAuto control range can be set
ALC Reference: The reference level of Gain Auto control can be set (Common with ExposureAuto)
ALC Area Type : The area for exposure control can be set(common with Exposure Auto)
ALC Customer Area Selector: Select the exposure area from 16 choices (4x4)
ALC Area Enable: This can Enable or Disable the area selected by ALC

Fig.45 ALC Area Type

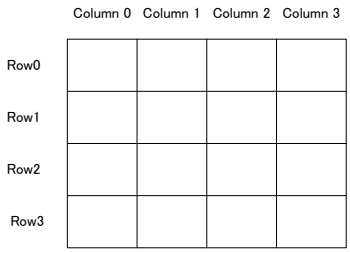


Fig.46 ALC Custom Area selector

8.2.5 Balance White Auto

This is a function to achieve auto white balance by using R and B gain.
There are three operations.

OFF: Manual operation
Once: Only when this operation is set, the auto white balance is executed.
Continuous: The auto white balance is continuously executed.
AWB Area Type : The control area of BALANCE WHITE AUTO can be set.
AWB Customer Area Selector: One of 16 (4x4) AWB setting areas can be selected.
AWB Area Enable : Set Enable or Disable for the area selected by ALC Custom Area Selector

Note: The figures for AWB Area Type and AWB Custom Area Selector are the same as ALC.

8.3. LUT

This function can be used to convert the input to the desired output characteristics.
The Look-Up Table (LUT) has 256 points for setup. The output level can be created by multiplying the gain data by the input level.

8.3.1 LUT Enable

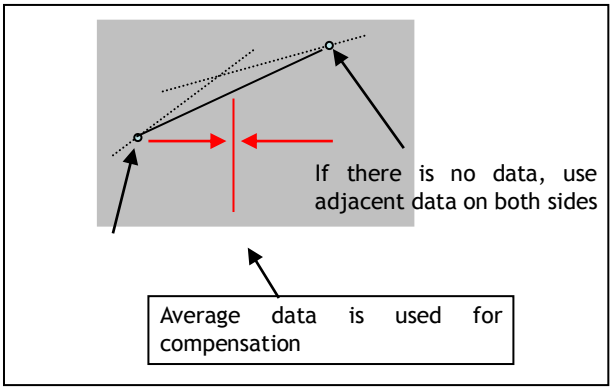
Can be selected from OFF, Gamma or LUT table.

8.3.2 LUT Index

This represents the “starting” or “input” pixel value to be modified by the Lookup Table. The SP-5000-GE2 has a 256-point Lookup Table, meaning the index points are treated like an 8-bit image with 0 representing a full black pixel and 255 representing a full white pixel. The index points are automatically scaled to fit the internal pixel format of the camera. This is common for all output configurations.

8.3.3 LUT value

This is the “adjusted” or “output” pixel value for a given LUT index. It has a range of 0 to 4095 (12-bit) and is automatically scaled to the bit depth of the current operating mode (8-bit or 10-bit). Note: linear interpolation is used if needed to calculate LUT values between index points. In the color mode, the LUT function works the same regardless of the color of the pixel.



Output Data = Video IN x LUT data

Fig. 47 LUT value

8.4. Gamma

This command is used to set gamma between gamma 0.45 and gamma 1.0 (OFF) in 16 steps. The gamma value is an approximate value.

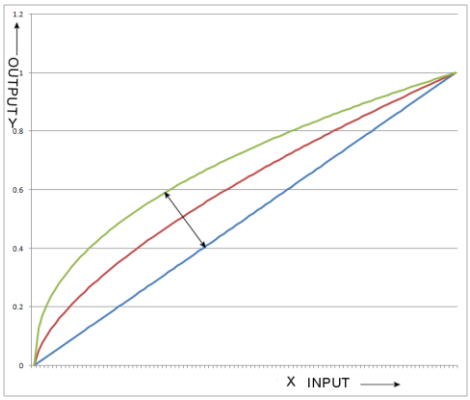


Fig. 48 Gamma compensation

8.4.1 Linear and Dark Compression

SP-5000-CXP2 has a dark compression circuit to improve the signal-to-noise ratio in the dark portion of the image.

Dark Compression 0: Dark Compression
1: Linear (Default)

Dark Compression	Function
Linear(Factory default)	No compression, Gamma=1.0
Dark Compression	Compress the signal level in the dark portion. It can improve the signal to noise ratio, but on the other hand, the linearity will be deteriorated.

8.5. Shading Correction

This function compensates for shading (non-uniformity) caused by the lens or the light source used. This compensation can be performed even if shading issues are not symmetrical in horizontal and/or vertical directions.

There are two methods of correction.

Flat shading correction:
The method to compensate the shading is to measure the highest luminance level in the image and use that data as the reference. Luminance levels of other areas are then adjusted so that the level of the entire area is equal. Compensation is performed using a block grid of 20 blocks (H) x 16 blocks (V). Each block contains 128 x 128 pixels. The complementary process is applied to produce the compensation data with less error.

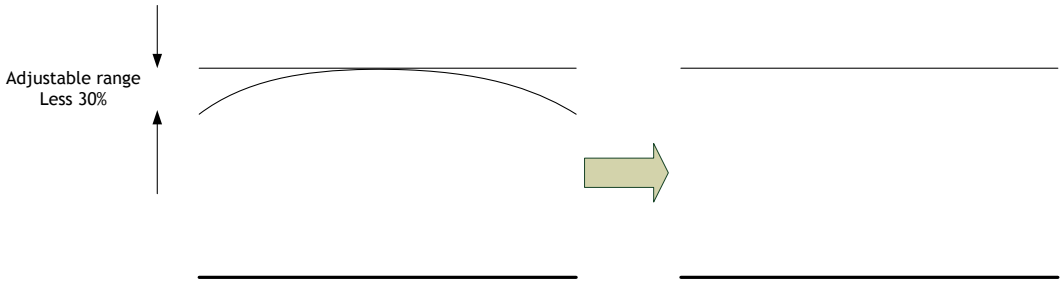
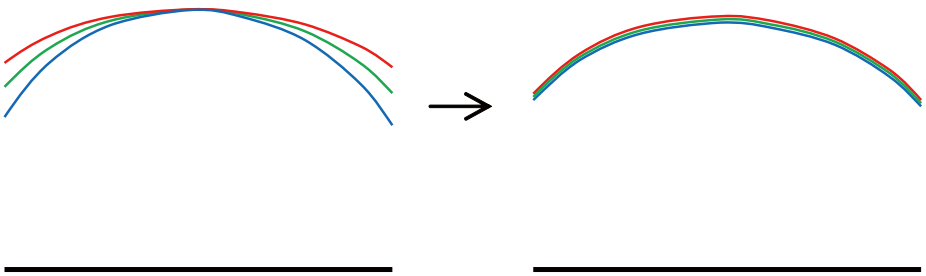


Fig. 49 Flat shading correction concept drawing

Color shading correction (For SP-5000C-GE2 only):
In this case, R channel and B channel are adjusted to match with G channel characteristics. The block grid for compensation is 20 blocks (H) x 16 blocks (V). Each block contains 128 x 128 pixels and the complementary process is applied to produce the compensation data with less error.



Before adjustment After adjustment

Fig.50 Color shading correction concept drawing

Note: Under the following conditions, the shading correction circuit may not work properly.

- If there is some area in the image with a video level less than 70%
- If part of the image or the entire image is saturated
- If the highest video level in the image is less than 300LSB (at 10-bit output)

8.6. Blemish compensation

The SP-5000M-GE2 and SP-5000C-GE2 have a blemish compensation circuit. This function compensates blemishes on the CMOS sensor (typically pixels with extremely high response or extremely low response). This applies to both monochrome and color versions. Pixels that fulfill the blemish criteria can be compensated by adjacent pixels in both columns and, in the case of the SP-5000C-GE2, the defective pixels can be compensated by the same Bayer color pixels in both adjacent columns. Please refer to the following drawing. As for white blemishes, the automatic detection function is available and after its execution, the data is stored in memory. The customer can use the data by setting the blemish compensation ON. For black blemishes, only compensation that has been done in the factory is available. The number of pixels that can be compensated is up to 512 pixels.

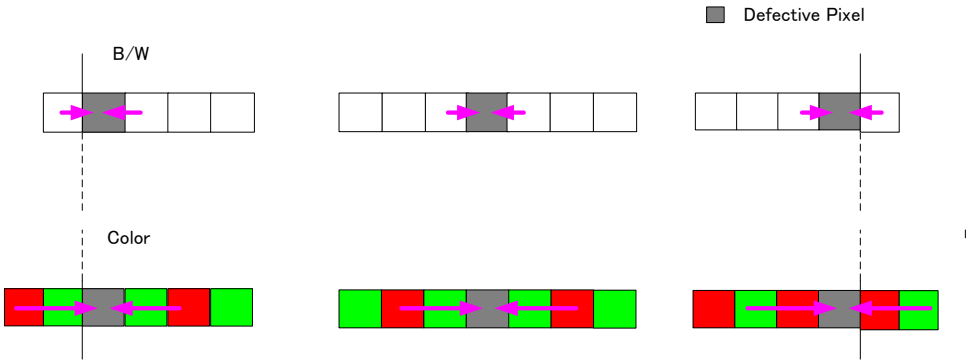


Fig.51 Blemish compensation

Note: If defective pixels are found consecutively in the horizontal direction, the blemish compensation circuit does not work.

8.7. Bayer color interpolation (Only for SP-5000C-GE2)

This function is available only for SP-5000C-GE2. The SP-5000C-GE2 uses a CMOS sensor with an RGB Bayer pattern. If the in-camera Bayer color interpolation is not used, the following RAW data can be output.

B	Gb	B	Gb	B	Gb	B	Gb	B	Gb
Gr	R	Gr	R	Gr	R	Gr	R	Gr	R
B	Gb	B	Gb	B	Gb	B	Gb	B	Gb
Gr	R	Gr	R	Gr	R	Gr	R	Gr	R

Fig.52 Bayer pattern

The RAW data contains only luminance information for each color and outputs as a monochrome signal. The Bayer color interpolation function can complement lacking color information on each pixel and output RGB or YUV color data as the result. Color interpolation compensates for the lack of color information by using information from adjacent pixels. The following is the concept drawing for the color interpolation process. It is invoked when one of the interpolated pixel formats (RGB or YUV) is selected.

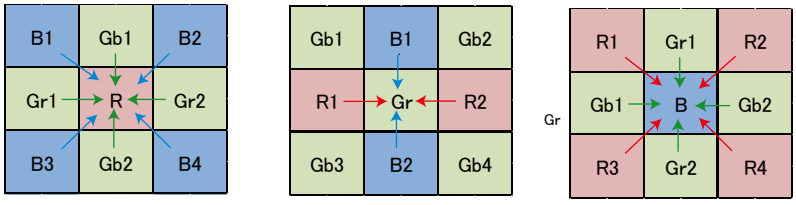


Fig.53 Color interpolation concept drawing

8.8 Lens control

The SP-5000M-GE2 and SP-5000C-GE2 can be used with 4 different types of auto iris lenses, in addition to standard lenses with manual iris control. If an auto iris function is to be utilized, the lens type used must be selected in Lens Select.

Table28. Lens selector

Lens Select	Description (Control with camera)	Note
P-Iris Lens	1) Iris position can be remotely controlled manually 2) Auto iris control is also available	If P-iris lens is used, the specific model name should be selected in Lens Select.
Motor controlled lens	1) Iris position can be remotely controlled manually 2) Auto iris control is also available	
Video iris lens	Only auto iris control is available	Factory Option
DC iris lens	Only auto iris control is available	Factory Option

8.8.1 About P-Iris

New Spark Series SP-5000M-GE2 and SP-5000C-GE2 come equipped with P-Iris control as part of the standard lens control function. The P-Iris system is a newly developed lens control method designed to control the iris more precisely. Especially for video cameras in surveillance applications utilizing megapixel CCD or CMOS imagers, it becomes a very important factor to control an iris in order to achieve the maximum camera performance. In surveillance applications, depending on shooting conditions, resolution and depth of field are important factors. The iris is deeply related with these factors. If the iris diaphragm is smaller, but not too small, resolution gets better and the depth of field is also deeper. The P-Iris system controls the iris diaphragm precisely and maintains the best image with the highest resolution and depth of field. P-Iris can also combine with gain and electronic shutter to keep the appropriate iris position under changing lighting conditions (ALC function).

8.8.2 Setting for P-iris lens being used

P-iris lenses use an absolute setting value control system and therefore, if the following parameters are input, precise iris position control is possible.

8.8.2.1 P-Iris lens select

Select the lens used from the P-iris select list. At this moment, there are no 1-inch P-Iris lenses available in the list. When P-Iris Les Select is opened, the following lenses are indicated but they are 2/3 inch format. If they are used, the corners of the image may be vignetted.

Table – 29 P-iris lens select

P-Iris lens select	Description	Control step number	Open F value
LM16JC5MM	Kowa 16mm 2/3”	74	F1.4
LM35JC5MM	Kowa 35mm 2/3”	73	F2.0

8.8.2.2 Step max.

Iris control step depends on lens. The setting value uses the value stored in the camera.

8.8.2.3 Position

The iris position can be set between 0 to Step Max. 0 means to open the iris and Step Max means to close the iris.

In the following conditions, the camera initializes P-iris control and acquires iris position.

1) When the camera is powered
2) When the lens is selected in P-Iris Lens Select
3) If the lens is changed in P-iris Lens Select

8.8.2.4 Current F value

The current F value is indicated by using iris position information. This can be indicated during auto iris operation. The relation between iris position and F value depends on the lens used.

8.8.2.5 P-Iris Auto min. / P-Iris Auto max.

This function can set the control range when the iris is operated automatically. Auto max. sets the limit when the iris goes open and Auto min. sets the limit when the iris goes closed. Auto max. can be set to fully open but Auto min. is stopped at F5.6 as lens performance typically degrades if the iris is closed beyond this point.

8.8.3 Motorized lenses

The SP-5000C-GE2 and SP-5000C-GE2 can use the 3-axis motorized lens control for zoom, focus and iris. The following functions are available via the motorized lens commands.

8.8.3.1 Iris

Open: While this command is supplied, the iris will continue to open.
Close: While this command is supplied, the iris will continue to close.
Stop: When this command is supplied, the iris operation stops.

8.8.3.2 Zoom

Wide: While this command is supplied, the zoom will continue to move towards wide angle.
Tele: While this command is supplied, the zoom will continue to move towards telephoto.
Stop: When this command is supplied, the zoom operation stops.

8.8.3.3 Focus+

Near: While this command is supplied, the focus will continue to shift closer to the camera.
Far: While this command is supplied, the focus will continue to move towards infinity.
Stop: When this command is supplied, the focus operation stops.

8.9 ALC

In the SP-5000M-GE2 and SP-5000C-GE2, auto gain, auto shutter and auto iris functions can be combined to provide a wide ranging automatic exposure control from dark to bright or vice versa. The functions are applied in the sequence shown below and if one function is disabled, the linkage between the other two is maintained.

In order to make the ALC function effective, set the Auto Iris Lens Control Signal Output to “ON”. The auto iris function (AIC) works together with AGC and Exposure Auto (ASC).

If the lighting condition is changed from bright to dark AIC — ASC — AGC
If the lighting condition is changed from dark to bright AGC — ASC — AIC

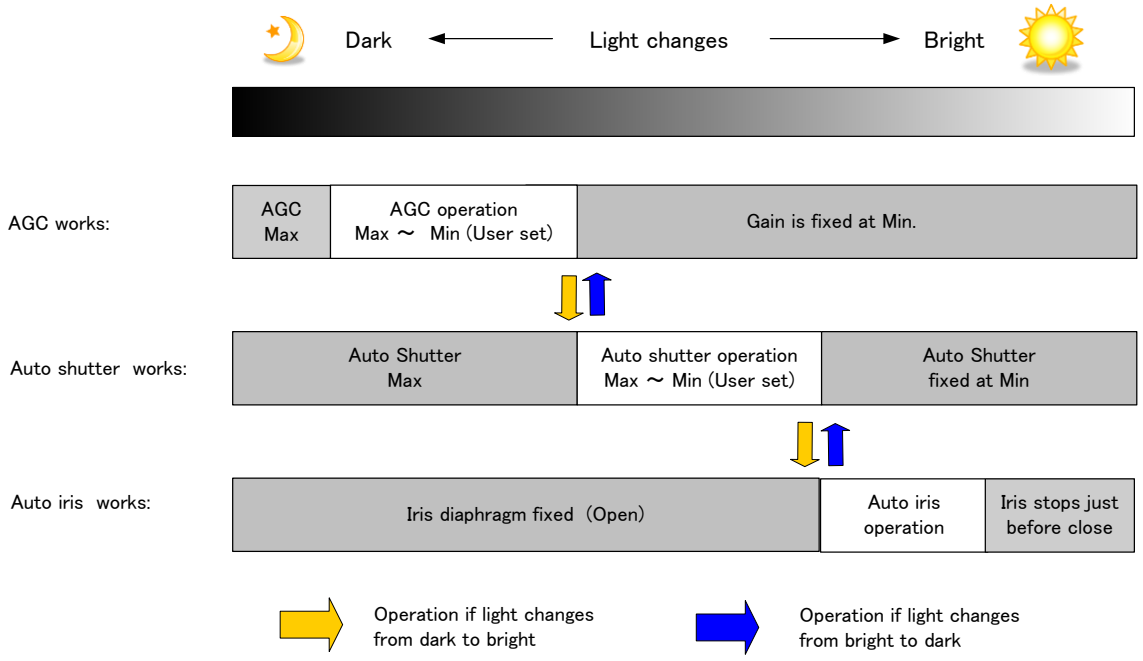


Fig.54 ALC function concept

ALC Reference will determine the target video level for AGC, Auto Shutter and/or Auto iris. For instance, if ALC Reference is set to 100% video level, AGC, Auto Shutter and/or Auto Iris will function to maintain 100% video level.

■ Please note that ALC function is available only in continuous mode, as well as RCT mode.

8.10 HDR (High Dynamic Range) (SP-5000M-GE2 only)

HDR sensing mode can be set when HDR Mode is set to ON while Exposure Mode is Timed.
The parameters to configure dynamic range are HDR_SLOPE Level 1, Level 2, Level 3 and Level 4.
The user can select any one of those parameters as required for their application.
In this mode, the timed exposure is used as the reference and the value selected in HDR_SLOPE will compensate to get an appropriate dynamic range by changing the exposure time.

Notes:

1. If the exposure mode is OFF and the HDR mode is set to ON, the exposure mode is automatically changed to Timed.
2. If horizontal binning and/or vertical binning are set to ON, the HDR mode cannot be set. In this case, the HDR mode must be set first before H-Binning and/or V-Binning are set.
3. In this mode, exposure overlapped behavior is not available and the frame rate is slower than the normal operation.
4. The exposure time value is fixed at the value when HDR Mode is activated. When the exposure time is changed, HDR Mode should be off. Once the exposure time is changed, the HDR Mode can be set to ON again.
5. In this mode, Exposure Auto function is disabled.

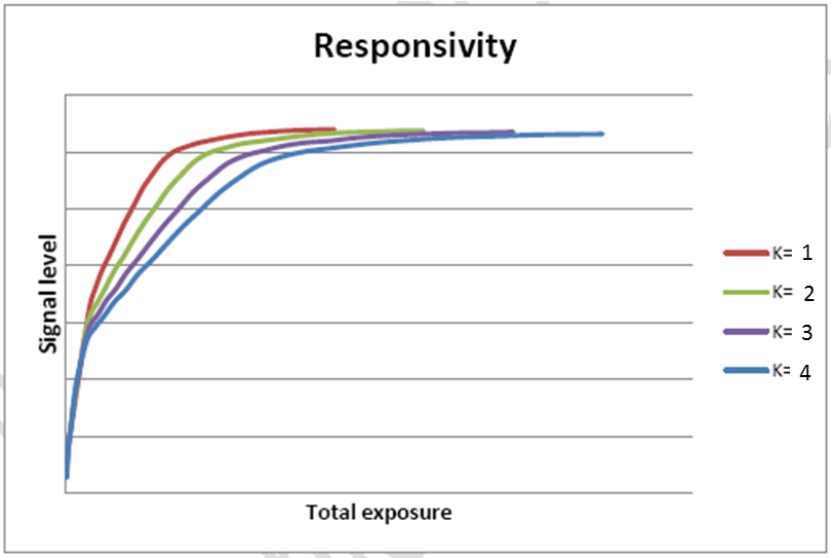


Fig.55 HDR characteristics

Knee Slope	Dynamic Range [%]
1	(200)
2	(400)
3	(800)
4	(1600)

9. Camera setting

9.1 Camera Control Tool

In the SP-5000M-GE2 and SP-5000C-GE2, control of all camera functions is done by the JAI SDK and Control Tool software. All controllable camera functions are stored in an XML file inside of the camera. The JAI SDK and Control Tool software can be downloaded from www.jai.com.

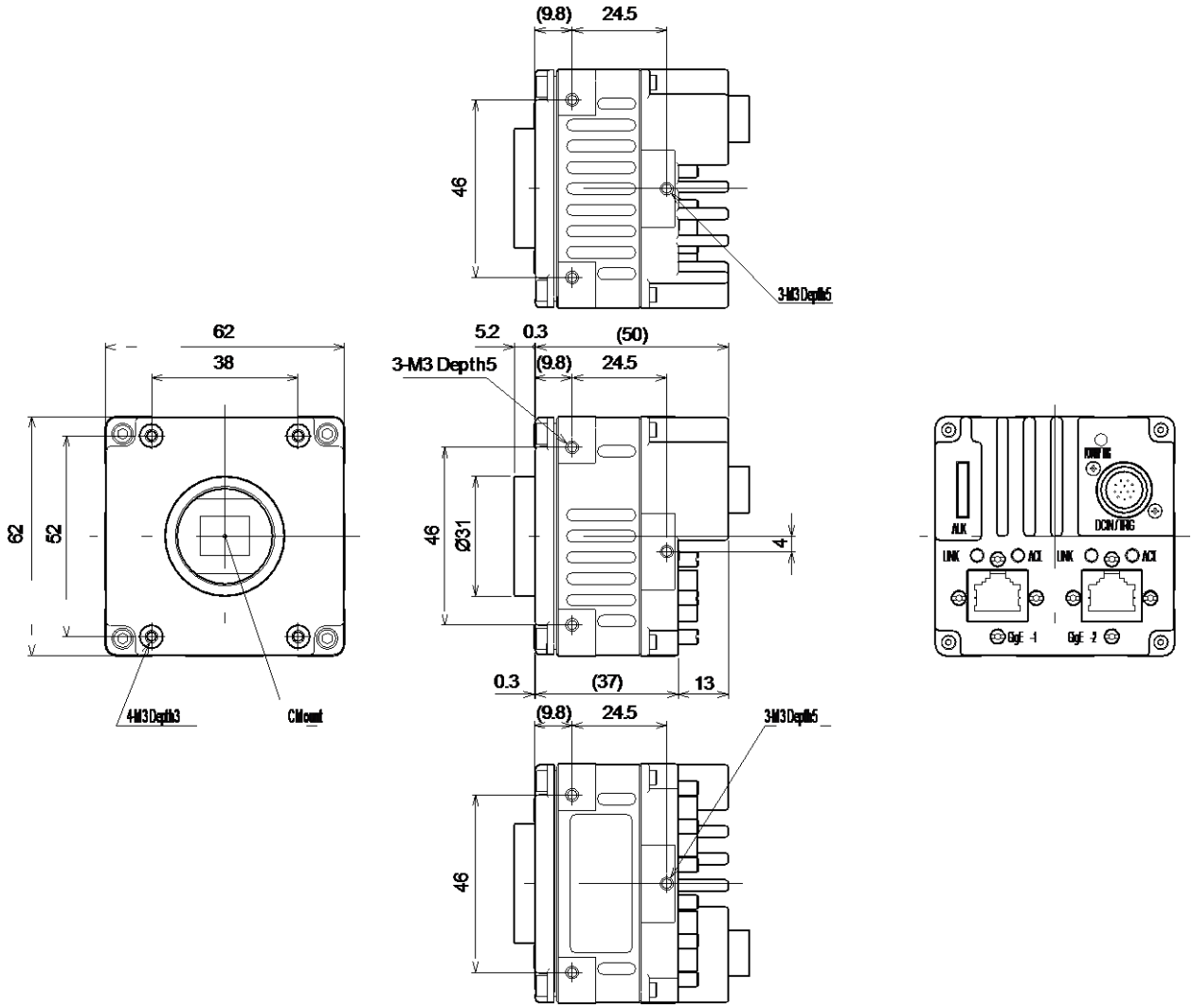
9.2 Camera Default Setting

When the camera is connected to PC and JAI SDK 2.0 is started up, XML file which stores default settings of the camera is downloaded to JAI_SDK camera control tool.

The default settings of SP-5000-GE2 are as follows.

Image Format	Bit allocation	8-bit
	Width	2560
	Height	2048
	Binning Horizontal	1(OFF)
	Binning Vertical	1(OFF)
Acquisition Control	Acquisition mode	Continuous
	Acquisition Frame Rate	44
Trigger Selector		Frame Acquisition Start
	Trigger Mode	OFF
	Trigger Activation	Rising Edge
	Trigger Source	Low
Trigger Overlap		Readout
Exposure Control	Exposure Mode	OFF
Gain	Analog base gain	0dB
	Gain Auto	OFF
Gamma		0.45
Video Send Mode		Normal

10. External appearance and dimensions



Dimensions tolerance: ± 0.3mm
Unit: mm

Fig.56 Outside dimensions

11. Specifications

11.1 Spectral response

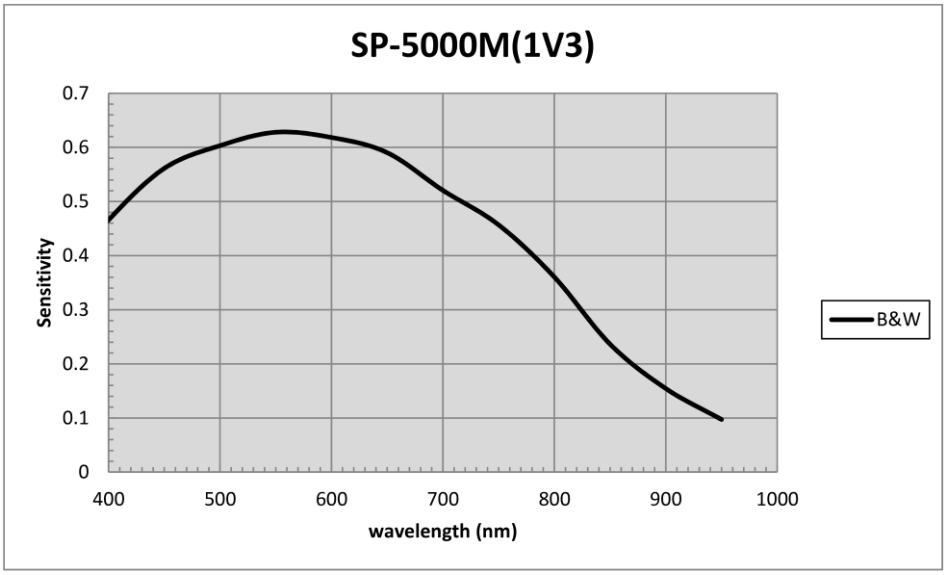


Fig.57 Spectral response (SP-5000M-GE2)

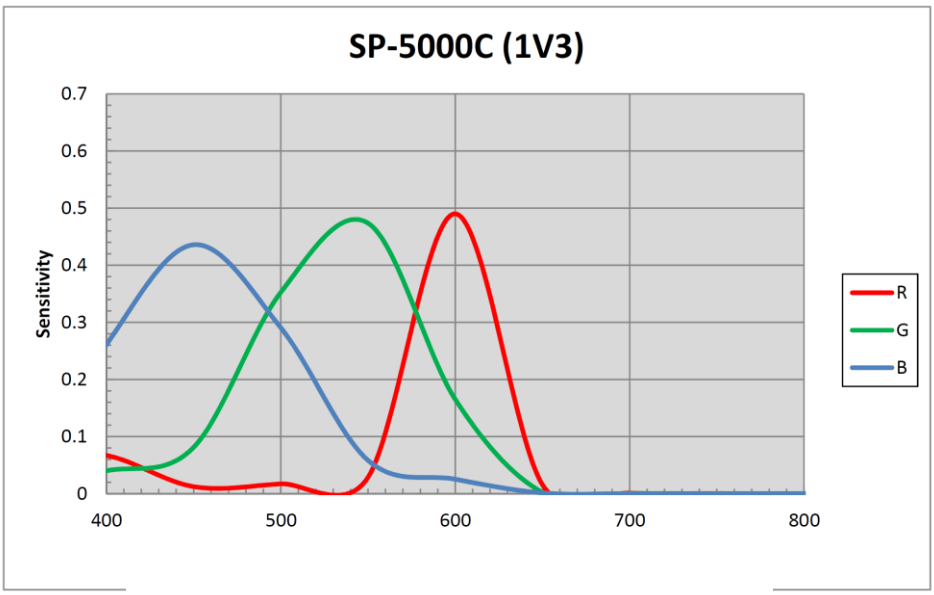


Fig.58 Spectral response (SP-5000C-GE2) (With IR Cut Filter)

Note: Full sensor response. IR-cut filter not shown.

11.2 Specifications table

Specifications				SP-5000M-GE2	SP-5000C-GE2
Scanning system				Progressive scan, 1-tap	
Synchronization				Internal	
Interface				1000Base-T Ethernet (GigE Vision 2.0) x 2Ports (100Base-T can be used) Complies with Single, sLAG (Static Link Aggregation) and dLAG (Dynamic Link Aggregation)	
Image sensor				1 inch Monochrome CMOS	1 inch Bayer color CMOS
Aspect Ratio				5:4	
Image size(Effective Image)				12.8 (h) x 10.24 (v) mm, 16.39 mm diagonal	
Pixel size				5 (h) x 5 (v) μm	
Effective Image output Pixels				2560 (h) x 2048 (v)	2560 (h) x 2048 (v)
Pixel Clock				48 MHz	
Maximum Acquisition Frame Rate per Tap Geometry (minimum is 0.125 fps for all geometries and formats)	Single Port			22 fps @ 8-bit 14 fps @ 10-bit Packed 11 fps @ 10-bit	22 fps @ Bayer 8-bit 14 fps @ Bayer 10-bit Packed 11 fps @ Bayer 10-bit 7.3 fps @ RGB 8-bit 14fps@ YUV411 Packed 11 fps @ YUV422 Packed 7.3 fps @ YUV444 Packed
	2 Ports LAG			44 fps @ 8-bit 29 fps @ 10-bit Packed 22 fps @ 10-bit	44 fps @ Bayer 8-bit 29 fps @ Bayer 10-bit Packed 22 fps @ Bayer 10-bit 14.6 fps @ RGB 8-bit 29 fps @ YUV411 Packed 22 fps @ YUV422 Packed 14.6 fps @ YUV444 Packed
	Binning	H1,V2		44fps @ 8-bit LAG	–
		H2,V1		88fps @ 8-bit LAG	–
		H2,V2		175fps @ 8-bit LAG	–
EMVA 1288 Parameters Absolute sensitivity Maximum SNR				At 10-bit output 23.50 p (λ = 525 nm) 41.48 dB	At 10-bit output 36.08 p (λ = 525 nm) 38.00 dB
SN ratio (traditional method)				Dark Compression:55 dB (Typical) Linear: 50dB (Typical) (0dB gain, Black)	Dark Compression: 53 dB (Typical) Linear: 45dB (Typical) (0dB gain, Green Black)
				42dB (Typical) (0dB gain, Level:890LSB, 10-bit)	37dB (Typical) (0dB gain, Green Pixel Level:890LSB, 10-bit)
Image Output format Digital	Full pixels			2560 (h) x 2048 (v)	Bayer 2560 (h) x 2048 (v)
	ROI	Width		8 ～2560, 2 pixels/step	8 ～2560, 2 pixels/step
		OFFSET X		0 ～2544, 16 pixels/step	0 ～2552, 4 pixels/step
		Height		8 ～2048 lines,2 line/step	8 ～2048 lines,2 line/step
		OFFSET Y		0 ～2046 lines, 2 line/step	0 ～2046 lines, 2 line/step
	Binning	H	1	2560 (H)	2560 (H)
			2	1280 (H)	–
		V	1	2048 (V)	2048 (V)
			2	1024 (V)	–
	Bit assignment			Mono8, Mono10, Mono10 Packed	BayerGR, BayerGR10, BayerGR10 Packed, RGB8 Packed, YUV411 Packed, YUV422 Packed, YUV444 Packed
Acquisition mode				Continuous / Single Frame / Multi Frame (1 ～255)	

Acquisition Frame Rate			44 fps (Max) ～ 0.125 fps (Min), at 8-bit output	
Trigger Selector		Acquisition	Acquisition Start/ Acquisition Stop	
		Exposure	Frame Start	
		Transfer	Acquisition Start/ Acquisition Stop / Frame Transfer	
Exposure mode			OFF, Continuous, Timed (EPS), Trigger Width	
Trigger option			OFF / PIV / RCT (with ALC function)	
Trigger Overlap			OFF / Readout (Frame Transfer Start only)	
Trigger Input Signal			Software, PG0/1/2/3, UserOutput0/1/2/3, Action1/2, Line5(Optical In1), Line6(Optical In 2), Line10(Option TTL In 2), Line11(Option LVDS In)	
Exposure Mode	Timed		10 µs (Min.) ～ 8 second (Max. Note1), Variable unit: 1 µs	
	Trigger Width		10 µs (Min.) ～ ∞ (Max.Note 1))	
Auto Exposure			OFF / Once / Continuous	
Auto Exposure Response Speed			1 ～ 8	
Digital I/O			Line Selector (12P): GPIO IN / GPIO OUT	
Black Level Adjust.	Ref. level		33.5LSB 10-bit (Average value of 100*100)	
	Adj. range		-64 ～ +63LSB 10-bit	
	Resolution		1 STEP = 0.25LSB	
Analog Base Gain			0dB, 6dB, 12dB	0dB, 6dB, 12dB (R/G/B individual setting)
Gain Control	Manual Adj. range		-0dB ～+24dB (Note2) 1 step=x0.01 (0.005dB to 0.08dB) Varies by setting value	-0dB ～+24dB (Note2) 1 step=x0.01 (0.005dB to 0.08dB) Varies by setting value
	WB Gain		—	R / B : -7dB to +15dB, 1 step = 0.01dB
	WB Area		—	4 x 4
	Color Temp. Range (Preset)		—	4600K, 5600K, 6500K
	WB Range		—	3000K ～ 9000K
	White Balance		—	OFF, Once, Continuous
Blemish Comp.	Detection		Detect white blemish above the threshold value (Black blemish is detected only by factory)	
	Compensation		Complement by adjacent pixels (Continuous blemishes are not compensated)	
	Numbers		512 pixels	
ALC			AGC, auto exposure, iris control can be combined and automatically controlled	
Gamma			0.45 ～ 1.0 (16 steps are available)	
LUT			OFF: γ=1.0, ON=256 points can be set	
HDR Correction			4 settings Level 1, 2, 3 and 4	—
Shading Compensation			Flat Field Block Comp. (20 x 16 blocks) Block size: 128 x 128 pixels	Flat Field, Color shading Block comp. (20 x 16 blocks) Block size: 128 x 128 pixels
Bayer Color Interpolation			—	3 x 3 matrix, Linear compensation
Power	Input range		DC+12V to +24V ± 10% (At the input terminal)	
	Current	Single Link	450mA (At 12V input, Full pixels)	450mA (At 12V input, Full pixels)
		LAG	520mA (At 12V input, Full pixels)	520mA (At 12V input, Full pixels)
	Power	Single Link	5.4W (At 12V input, Full pixels)	5.4W (At 12V input, Full pixels)
		Lag	6.25W (At 12V input, Full pixels)	6.25W (At 12V input, Full pixels)
Lens mount			C mount Rear protrusion of the lens is less than 10 mm	
Flange back			17.526 mm, Tolerance: 0 to -0.05 mm	
Optical filter			Protection glass: Not provided	IR cut filter (Half value is 670 nm)

Operating temperature/Humidity Performance guaranteed	-10°C to +50°C / 20 – 80% (No-condensing)
Operating Temperature / Humidity	-45°C to +70°C/20% to 80% (No-condensing)
Storage Temp. / Humidity	-45°C to +70°C/20% to 80 % (no-condensing)
Regulation	CE (EN61000-6-2 and EN61000-6-3), FCC part 15 class B, RoHS, WEEE
Housing Dimensions	62 x 62 x 55.5 mm (W x H x D) (excluding protrusion)
Weight	215g

Note1): Usable performance will be up to 2 seconds.

Note2): A minimum of +12dB of gain can be applied without causing any breaks in the histogram.

Note3): Approximately 5 minutes pre-heating is required to achieve these specifications.

Note4): The above specifications are subject to change without notice.

Appendix

1. Precautions

Personnel not trained in dealing with similar electronic devices should not service this camera.
The camera contains components sensitive to electrostatic discharge. The handling of these devices should follow the requirements of electrostatic sensitive components.
Do not attempt to disassemble this camera.
Do not expose this camera to rain or moisture.
Do not face this camera towards the sun, extreme bright light or light reflecting objects.
When this camera is not in use, put the supplied lens cap on the lens mount.
Handle this camera with the maximum care.
Operate this camera only from the type of power source indicated on the camera.
Power off the camera during any modification such as changes of jumper and switch setting.

2. Typical Sensor Characteristics

The following effects may be observed on the video monitor screen. They do not indicate any fault of the camera, but are associated with typical sensor characteristics.

V. Aliasing
When the CMOS camera captures stripes, straight lines or similar sharp patterns, jagged edges may appear on the monitor.

Blemishes
All cameras are shipped without visible image sensor blemishes.
Over time some pixel defects can occur. This does not have a practical effect on the operation of the camera. These will show up as white spots (blemishes).
Exposure to cosmic rays can cause blemishes to appear on the image sensor. Please take care to avoid exposure to cosmic rays during transportation and storage. It is recommended using sea shipment instead of air flight in order to limit the influence of cosmic rays on the camera. Pixel defects/blemishes also may emerge due to prolonged operation at elevated ambient temperature, due to high gain setting, or during long time exposure. It is therefore recommended to operate the camera within its specifications.

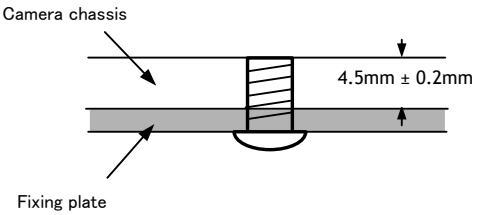
Patterned Noise
When the sensor captures a dark object at high temperature or is used for long time integration, fixed pattern noise may appear on the video monitor screen.

3. Caution when mounting a lens on the camera

When mounting a lens on the camera dust particles in the air may settle on the surface of the lens or the image sensor of the camera. It is therefore important to keep the protective caps on the lens and on the camera until the lens is mounted. Point the lens mount of the camera downward to prevent dust particles from landing on the optical surfaces of the camera. This work should be done in a dust free environment. Do not touch any of the optical surfaces of the camera or the lens.

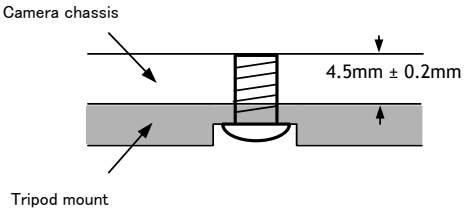
4. Caution when mounting the camera

When you mount the camera on your system, please make sure to use screws of the recommended length described in the following drawing. Longer screws may cause serious damage to the PCB inside the camera.



Mounting the camera to fixing plate

If you mount the tripod mounting plate, please use the provided screws.



Attaching the tripod mount

5. Exportation

When exporting this product, please follow the export regulation of your own country.

6. References

1. This manual can and datasheet for SP-5000M-GE2 / SP-5000C-GE2 can be downloaded from www.jai.com
2. Camera control software can be downloaded from www.jai.com

Manual change history

Date	Revision	Changes
April 2014	Preliminary	New Release
July 2014	1.0	New release
Aug. 2014	1.1	Revise LAG settings information
Sept. 201	1.2	Revise Spectral response
Oct. 2014	1.3	Revised B/W Spectral response with wider wave length, Add the description of the dark compression

User's Record

Camera type: **SP-5000M-GE2 / SP-5000C-GE2**

Revision: **……..**

Serial No. **……..**

Firmware version. **……..**

For camera revision history, please contact your local JAI distributor.

User's Mode Settings.

User's Modifications.

Europe, Middle East & Africa	*Asia Pacific*	*Americas*
Phone +45 4457 8888 *Fax +45 4491 3252*	*Phone +81 45 440 0154* *Fax +81 45 440 0166*	*Phone (toll-free) +1 800 445 5444* *Phone +1 408 383 0300*

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